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The Volume 10

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highlights

- Improving Unconfined Compressive Strength
- Productivity of Concrete
- Hydraulic Behavior of Dune Sand Bentonite
- Stress Management among Artisans

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Contents of the Volume

From the Chief Author's Desk

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Behavior of Reinforced Sub bases on Expansive Soil Sub grade

GJRE Classification (FOR)
090503, 090506, 120202 & 040607

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Abstract- **Evaluation Studies on flexible pavement system were carried out by using the different reinforcement materials in the gravel subbase courses laid on expansive soil subgrades. Cyclic Load tests were carried out in the field by placing a circular metal plate on model flexible pavements. It is observed that the maximum load carrying capacity associated with less value of rebound deflection is obtained for Geogrid reinforced stretch followed by bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber reinforced stretch in the flexible pavement system laid on expansive subgrades.**

Keywords: Expansive soil; Flexible Pavement; Reinforcement; Cyclic Plate Load Tests

I. INTRODUCTION

Expansive soils are known to cause damage mostly to light structures, such as residential dwellings and road pavements. The losses due to extensive damage to highways running over expansive soil subgrades are estimated to be in billions of dollars all over the world Jones and Holtz(1973); Steinberg(1992). Various remedial measures like soil replacement Snethen et al., (1979); Chen, (1988), prewetting Subba Rao and Satyadas, (1980), moisture control Mohan and Rao,(1965); Marienfeld and Baker,(1999), lime stabilization Holtz and Gibbs, (1956); Thompson and Robnett, (1976) have been practiced with varied degree of success. However, these techniques suffer from certain limitations respect to their adaptability like longer time periods required for prewettting the highly plastic clays, Felt,(1953); Steinberg,(1977), difficulty in constructing the ideal moisture barriers Snethen et al,(1979); Chen,(1988), pulverization and mixing problems in case of lime stabilization Holtz,(1969); Ramana Murty,(1998) and high cost for hauling suitable refill material for soil replacement Snethen et al,(1979); Chen,(1988)etc.

Reinforced earth technique has been gaining popularity in the field of civil engineering due to its highly versatile and flexible nature. It has been used in the construction of retaining walls, embankments, earth dams, foundation beds for heavy structures on soft grounds, viaduct bridges and other applications Henry Vidal, (1968); Hausmannn, (1990); Rao, (1995). With the advent of geosynthetics in civil engineering, reinforced earth technique has taken a new turn in its era. The practice of reinforced earth technique became easy and simple with geosynthetics. In spite of its wide use in various engineering practices, its application in the construction of pavements is very much limited Prasada Raju, (2001). However, geosynthetic layer has been used as a separator at the subgrade – pavement interface Al-Qadi and Bhutta, (1999); Brandon et al,(1996) to prevent the entry of pavement materials into the subgrade or subgrade material into the pavement materials. It is felt that the major problems of expansive subgrades to the pavements are detrimental heave and severe cracking Snethen et al, (1979). The pavement may crack either due to uneven heave during wetting or due to shrinkage of the subgrade during drying. In the recent years, to rehabilitate the existing pavements laid on expansive soil beds, geosynthetic layer is being placed on the existing pavement over which asphalt over lay (new wearing coat) is laid Steinberg, (1992); Buffon, (1989).This is aimed at to control the pavement failure due to propagation of cracks from the expansive subgrades. However, in this case, the subgrade cracking propagates right upto the geosynthetic layer, which may weaken the pavement system. Inspite of this drawback, not much can be done for an old pavement. But for new pavements, the propagation of cracking from subgrade to the pavement can be controlled by placing the geosynthetic layer nearer to the subgrade. In the present work instead of using geosynthetic layer individually as a separator, it is used to reinforce one of the flexible layers whereby the pavement system can be strengthened besides serving other purposes. Moreover, the pavement performance may be preserved inspite of softening of the subgrade due to heave by improved load distribution characteristics.

Reinforcement of soils with natural and synthetic fibres is potentially an effective technique for increasing soil strength. The growing interest in utilizing waste materials in civil engineering applications has opened the possibility of constructing reinforced soil structure with unconventional backfills, such as waste plastics and waste tire shreds. The results of direct shear tests performed on sand specimens by Gray and Osashi (1983) indicated increased shear strength and ductility, and reduced post peak strength loss due to the inclusion of discrete fibers. The study also indicated that shear strength is directly proportional to fiber area ratio and

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length of fiber up to certain limit. These results were supported by number of researchers using consolidated drained triaxial tests like Gray and Al-Refeai (1986); Gray and Maher (1989); Ranjan et al. (1996) ; Michaowski and Cermak (2003); Jadhao and Nagarnaik (2008).The addition of fibers increases the CBR ,ultimate strength ,stiffness and resistance to liquefaction, shear modulus and damping of reinforced the sand by Lindh and Eriksson(1991); Temel and Omer (2005).The results of compaction tests for a silty, clay soil specimen reinforced with fibers indicate that increasing the volume of fibers in the soil generally causes a modest increase in the maximum dry unit weight, and a slight decrease in the optimum moisture content by Fletcher and Humphries,(1991) . Scrap tyres are a type of waste material for which several beneficial uses have been proposed and put into practice by Ahmed,(1993).The use of tyre shreds or mixtures of tyre shreds and sand (ie, rubber-sand) as lightweight fill Bernal et al., (1997) could provide an alternate avenue for waste tyre disposal. Using shredded waste tyres as a lightweight fill material for road construction has proven to be another beneficial use of this waste product. Al-Wahab and Al-Qurna,(1995) based on his experience in admixture and reinforcement testing, found that the typical sizes of laboratory specimens do not allow for consistent mixing of the shreds within the soil matrix. Lee et al., (1999) also used tyre chips, which was defined as shreds that had maximum dimensions of 12 mm to 50 mm. The authors were able to obtain consistent results of strength gain through triaxial testing. Several investigators have conducted research of different types of reinforcement and materials. However, the amount of information available on reinforcement is still limited. In the present investigation Direct shear and CBR tests were conducted in the laboratory for gravel materials with different percentages of waste plastics and waste tyre rubber to obtain optimum percentage of reinforcement material. An attempt is made to study the performance of reinforced gravel subbase layer with different materials, such as Geogrid, Bitumen Coated Chicken Mesh, Bitumen Coated Bamboo Mesh, Waste Plastics and Waste Tyre Rubber in model flexible pavement construction laid on expansive soil subgrades. Cyclic load tests were carried out by placing a circular metal plate directly on the flexible pavement laid on expansive subgrades. Keeping in view the high cost of geogrid, other materials like bamboo mesh, waste plastics and waste tyre rubber were also tried for their use as reinforcing materials.

II. EXPERIMENTAL STUDY

A. *Materials used*

The following materials are used in this study.
Soil: Expansive soil collected from Godilanka near Amalapuram was used for this investigation as a subgrade material. The soil properties are WL=75%, WP=35%, WS=12%, I.S. Classification=CH (Clay of high compressibility), OMC=23%, MDD=15.69 kN/m3, Differential free swell=150 %, Soaked CBR=2.0%.Permeability = 1.5 × 10 -7 cm/sec.

Gravel: Gravel collected from Dwarapudi, near Rajahmundry was used as subbase course. The soil properties are WL=38%, WP = 20 %, OMC=13 %, MDD=18.05 kN/m3, Soaked CBR=8.0%, Permeability = 1.2 × 10 -1 cm/sec.

Geogrid: Netlon CE 121 Geogrid with a peak tensile strength of 7.68 kN/m and aperture size of 8mm × 6mm was used.

Chicken mesh: Chicken Mesh with a peak tensile strength of 8.85 kN/m and an aperture size of 2mm × 2mm coated with 80/100 grade bitumen is used.

Bamboo mesh: Bamboo Mesh of thickness 1mm with a peak tensile strength of 26.32kN/m coated with 80/100 grade bitumen was used.

Waste plastic strips: Waste plastic strips having a size of 12 mm × 6 mm and a thickness of 0.5 mm is used in this study.

Waste tyre rubber: Waste Tyre Rubber chips passing through 4.75 mm sieve are used in this study
Road metal: Road metal of size varying between 45-63mm was used for the base course

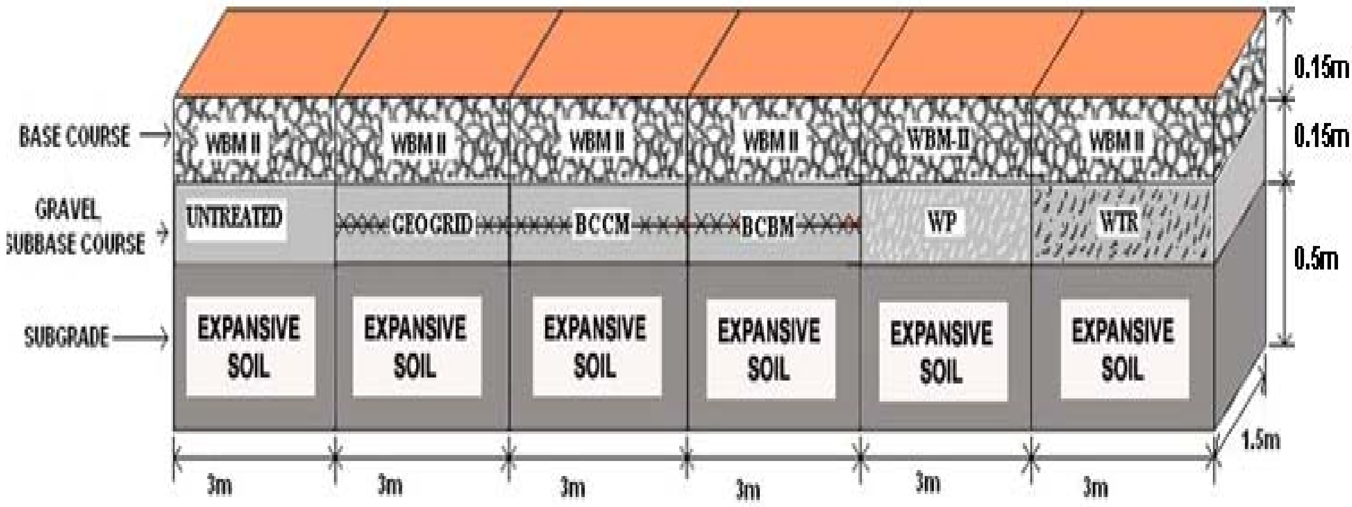
III. LABORATORY EXPERIMENTATION

A. *Direct shear and C B R tests*

The required percentage of waste plastics/waste tyre rubber by dry weight of soil is mixed uniformly with the sub base soil and the required water content corresponding to OMC was added to the soil and compacted to maximum dry density. The direct shear and CBR tests were conducted as per IS: 2720 (part XIII, 1986) and IS: 2720 (Part-XVI, 1979), in the laboratory, by using different percentages of waste plastics and waste tyre rubber mixed with gravel materials, with a view to find the optimum percentages

IV FIEL EXPERIMENTATION

In this study six alternative test tracks (Geogrid reinforced subbase, Bitumen coated Chicken mesh reinforced sub base, Bitumen coated bamboo mesh reinforced subbase, Waste plastics reinforced subbase, Waste Tyre Rubber reinforced subbase and Untreated
sub base) were prepared on expansive soil subgrade with gravel subbase materials separately, as shown in Figure 1 and the details of which are presented in the following sections.



BCCM: Bitumen Coated Chicken Mesh **WP: Waste Plastics**
BCBM: Bitumen Coated Bamboo Mesh **WTR: Waste Tyre Rubber**

Fig.1 Preparation of Test Stretches

A. Preparation of test stretches

Tests track each of size 3m long and 1.5m wide was excavated to an average depth of 0.8m as shown in Fig. 2(a). Out of which 0.5m was for laying subgrade, 0.15m was for laying subbase pulverized to small pieces with wooden rammers. In the prepared test pit, the pulverized expansive soil was mixed with water at OMC and was laid in the excavated pit in 10 layers, each layer of 0.05 m compacted thickness, amount to a total thickness of 0.5 m as shown in the Fig. 2(b) . On the prepared sub grade gravel subbase material mixed with water content at OMC laid in 2 layers, each of 0.075m compacted thickness to a total thickness of 0.15m was laid. The reinforcement materials viz. Geogrid, Bitumen Coated Chiken Mesh (BCCM), Bitumen Coated Bamboo Mesh (BCBM) was kept above the first compacted layer of each pit as shown in the Fig.2(c). For the Waste Plastic/Waste Tyre Rubber reinforced stretchs, the reinforcement materials (optimum percentage based on laboratory Shear and CBR) was mixed uniformly throughout the subbase material as shown in the Fig.2 (d). On the prepared subbase two layers of WBM-II each of 0.075m compacted thickness to a total thickness of 0.15m using crushed stone aggregate of size 45mm to 63mm with murrum as binding material was laid. The compaction was done with the help of hand operated roller. A critical view of field stretches used for finding the best alternative reinforcement material in the flexible pavement system is shown in the Fig.2 (e).

B. Cyclic load testing

Cyclic Plate load tests were carried out for different test stretches with different reinforcement materials viz. Geogrid, Chicken Mesh, Bamboo mesh, Waste plastics, Waste Tyre Rubber and unreinforced gravel stretch under normal tyre pressures using circular steel plate of diameter 0.3m. A loading frame was arranged centrally over the test track as shown in the Fig.2 (f). The loading frame was loaded with the help of sand bags. A steel base plate of 0.3m diameter was placed centrally over the test pit. Hydraulic Jack of capacity 100kN was placed over the plate attached to
the loading frame with a loading cylinder. Three dial gauges with a least count of 0.01mm were placed on the metal flats to measure the settlements. A load of 5kPa was applied as a seating load with the help of hydraulic jack and released. The load was applied in increments corresponding to tyre pressures of 500, 560, 630,700 and 1000 kPa and each pressure increment was applied cyclically until there is insignificant increase in the settlement of the plate. These tests were carried out on the prepared expansive soil subgrade with five different reinforcement materials.

Fig. 2(a) Excavated Model Pavement Stretch

Fig. 2(b) Prepared Expansive Soil Subgrade

Fig. 2(c) Placing of Reinforcement Material in the Subbase Course

Fig.2(d) Mixing of Waste Plastics with Gravel

Fig.2(e) Prepared Model Flexible Pavement Stretch

Fig. 2(f) Experimental Set - Up for conduct of Cyclic Plate Load Test

V. Discussion on Test Results

Direct shear tests and CBR tests were conducted by using different percentages of waste plastics mixed with gravel material for finding the optimum percentage of waste plastics.

A. Direct shear and C B R test results

Based on the laboratory test results, it is observed that, for gravel reinforced with waste plastics, the angle of internal friction values are increased from 36^0 to 44^0 with 0.3 % of waste plastics and thereafter decreased with further additions. The cohesion values are increased from 14.72 to 27.76 kN/m^2 with 0.3 % of waste plastics and thereafter decreased. It is also observed that cohesion and angle of internal friction values for gravel materials are increased from 11.77 to 26.48 kN/m^2 and 36^0 to 43^0 respectively with 5.0 % of waste tyre rubber chips and thereafter decreased. For gravel reinforced with waste plastic strips, soaked CBR values are increased from 8.0 to 16.42 for 0.30 % of waste plastics and from 8.0 to 13.32 for 5.0 % of waste tyre rubber respectively. From the results of direct shear and California bearing ratio tests, the optimum percentage of waste plastics and waste tyre rubber for gravel materials are equal to 0.3% and 5.0% respectively.

b. Load test results

The cyclic load test results for the different alternatives are presented in the following section.

Pressure – total deformation behaviour on expansive soil subgrades From the test results it is observed that the deformation attained equilibrium after six cycles of loading and unloading for all the pressure increments tried during the study. Higher deformations are recorded at higher load intensities as expected. From the pressure – total deformation curves shown in Fig.3 (a) for different test stretches the load carrying capacity is substantially increased for Geogrid reinforced subbase stretch. For all the deformation levels Geogrid reinforced stretch has shown better performance followed by BCCM, BCBM, WP and WTR stretches respectively. At all load intensities the waste tyre rubber reinforced stretch has shown higher deformation than other reinforced stretches

Pressure-elastic deformation behaviour on expansive soil subgrades

It was observed that load carrying capacity was substantially increased for reinforced Geogrid subbase for all the deformation levels which exhibits high load carrying capacity followed by BCCM, BCBM, WP and WTR stretches as shown in the Fig.3 (b). It can be observed that the elastic deformation values are substantially decreased for Geogrid reinforced subbase stretch compared to other stretches.

Geogrid and chicken mesh provide better interlocking with the soil particles thus ensuring adequate anchorage during loading. Relatively lower performance of bitumen coated bamboo mesh could be attributed to its smooth surface to mobilize adequate friction. Waste plastics and waste tyre rubber are more elastic which can lead to higher deflections compared to other reinforced materials tried in this investigation. The improvement in the load carrying capacity could be attributed to improved load dispersion through reinforced subbase on to the subgrade. This in-turn, results in lesser intensity of stresses getting transfer to subgrade, thus leading to lesser subgrade distress.

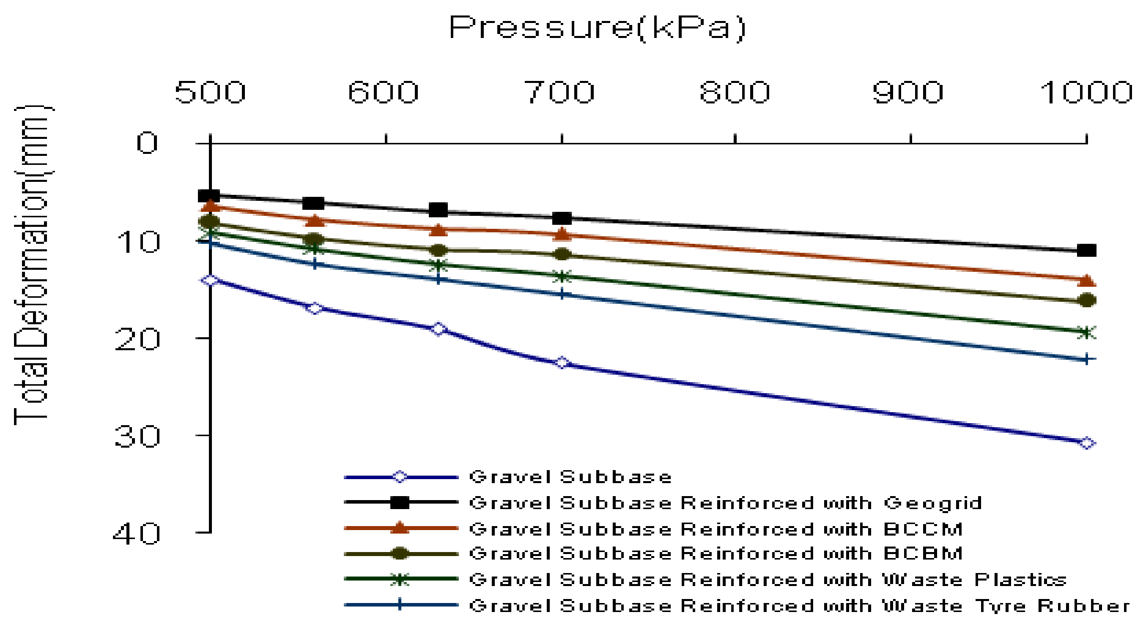


Fig. 3(a) Pressure-Total deformation Curves for Different Pavement Stretches laid on Expansive Soil subgrade

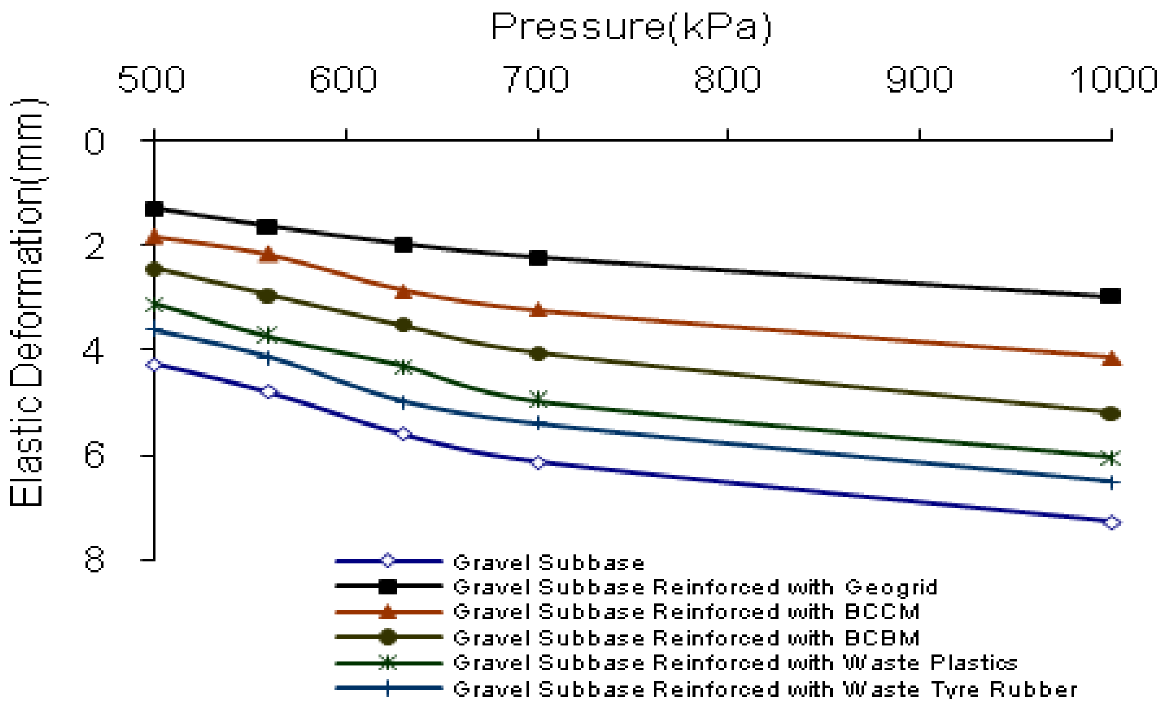


Fig. 3(b) Pressure-Elastic deformation curves for Different Pavement Stretches Laid on Expansive Soil Subgrade

.VI. Conclusions

The load carrying capacity of the model flexible pavement system is significantly increased by introducing reinforcement material in gravel subbases laid on expansive soil subgrade.

The total and elastic deformation values of the flexible pavement system are decreased by the provision of the reinforcement viz: Geogrid, BCCM, BCBM, WP and WTR stretches in gravel subbases laid on expansive soil subgrade.

The maximum load carrying capacity followed by less value of rebound deflection is obtained for Geogrid reinforced subbase stretch followed by other stretches laid in gravel subbase of the flexible pavement system.

The improvement of the pavement performance is cognizable for the two reinforcement materials tried viz., geogrid and bitumen coated chicken mesh. Both geogrid and bitumen coated chicken mesh provide excellent interlocking of soil particles, thereby resulting in better performance compared with bitumen coated bamboo mesh, waste plastics and waste tyre rubber.

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Improving Unconfined Compressive Strength of Peat with Cement, Polypropylene Fibers, and Air curing technique

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GJRE Classification (FOR)
040607, 040403, 090503 & 040306

***Abstract*- Peat soil is one of the softest types of soil. Various methods have been used in the past to strengthen peat soil deposits. In this research unconfined compressive strength (UCS) of peat soil is being studied while the peat soil was at its undisturbed state, stabilized with ordinary Portland cement, and also when the stabilized peat soil is mixed with polypropylene fibers. Unconfined compressive strength for either stabilized peat with polypropylene fibers or without polypropylene fibers were studied at different curing ages from immediately after molding (0 day) to 7, 28, 90, and 180 days. All samples were cured in air, and the procedure includes leaving the stabilized peat soil in normal room temperature and in air through the curing period. This curing procedure is called air curing technique. The procedure used to strengthen the peat soils show that, UCS values of stabilized peat soil were considerably increased through curing process. As the curing time for the stabilized peat soil continues, the moisture contents of the UCS samples are reduced (through evaporation), and therefore the weight of water divide by weight of cement (W/C) of stabilized samples are reduced. As W/C for samples reduce, the stabilized samples gain strength through curing time. The strength gain continues beyond 28 days which is usual for concrete mixes. The UCS values for the stabilized peat soil show that, the strength increase up to 6 month of curing period. Actually, the UC strength values at six month of curing is higher than three month curing, and three month curing strength values are higher than the 28 days of curing.**

Addition of polypropylene fibers to the mixture of peat, ordinary Portland cement as a none reactive additive not only increases the UCS values of stabilized peat soil, rather it contributes a considerable amount of uniformity and intactness to the stabilized peat soil samples as well.

Keywords; peat soil, ordinary Portland cement, polypropylene fibers, air curing, unconfined compressive strength.

I. Introduction

Design and construction method for civil-infrastructural works are very much influenced by soils and soil characteristics**.** Peat soil, is among the worst of foundation materials, and is one of the most troublesome of the soft soil in engineering term.[1]

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Civil engineers usually try to avoid construction projects on peat soils, and would rather to do one of the followings when they are to build on peat soils;

a) Remove and replace the peat soil by suitable inorganic soils such as sand or a mixture of sand and silt or clay.

b) Use of piles to transfer the loads to a deeper and suitable depth

c) Use of synthetic materials to cover the ground in order to distribute the load to a larger area, which is usually used for line constructions.

d) Use of stabilization techniques, to strengthen the peat soil.

In this laboratory research, method "d" is been used to stabilize peat soil samples using different amounts of ordinary Portland cement as binding agent and polypropylene fibers as none chemically active additives, and "air curing technique" was used to cure the stabilized peat soil samples described by Kalantari, and Huat (2008)[2]. Unconfined compressive strength test has been used as the main strength evaluation test for the stabilized peat soil samples through the curing periods.

II. Test Materials

Materials used in this laboratory research include;

- **a)** peat soil
- **b)** Ordinary Portland cement
- **c)** Polypropylene fibers

Peat soil samples used for the study were collected as disturbed and undisturbed according to AASHTO T86-70 and ASTM D42069 described by Bowles (1978)[3], and Dept. of Army, USA (1980)[4] from Kampung, Jawa in the western part of Malaysia. Table 1 presents the properties of the in situ (field) peat soil. The stabilizing agent used for the peat soil samples was ordinary Portland cement, and polypropylene fibers (Figure 1) was used as none chemically active material to the stabilized peat soil. Table 2 presents the specifications for the fibers used in the research.

Table 1; Properties of the peat soil used in the study

Properties	Standard Specifications *	Values
Depth of sampling		5 – 100 Cm.
Moisture content (natural)	ASTM D2216	198 - 417 %
In situ (natural) bulk density		10.23–10.4 kN/m^3
Classification	ASTM D5715	Fibrous
Classification	Van Post	H_1- H_4
Liquid Limit	BS 1377	160 %
Plastic Index	ASTM D424-59	N.P.
PH	BS 1377	6.81
Organic content	ASTM D2974	80.23 %
Wopt	A ASHTO T 180-D	130 %
$\gamma d(max)$	AASHTO T 180-D	4.89 kN/m^3
Permeability (undisturbed)	ASTM D2434-68	4.9 x 10 -4 (cm/sec)
e_o (initial void ratio)	BS 1377, ASTM D2435-70	12.55
Cc(compression index)	BS 1377, ASTM D2435-70	3.64
Cr (recompression index)	BS 1377, ASTM D2435-70	0.490
C'_u (effective cohesion)	ASTM D 4767	0 kPa
φ'_u (effective friction angle)	ASTM D 4767	36.64°
UCS (remolded)	ASTM 2166-6, AASHTO T208-706	22 kPa

Table 2: Polypropylene fibers specifications

Property	Specification
Color	Natural
Specific gravity	0.91 gr/cm^3
Fiber Length	12mm
Fiber Diameter	18 micron – nominal
Tensile strength	300 – 440 MPa.
Elastic modulus	6000 – 9000 (N/mm^2)
Water absorption	None
Softening point	160^{oc}

III .EXPERIMENTAL PROGRAM

Experimental program for this study began with index properties tests for the plain peat soil, such as sieve analysis, Atterberg limits, and organic contents. Then more detailed tests were conducted on the undisturbed peat samples in order to evaluate its original behaviors. These tests include permeability, unconfined compressive strength (UCS), consolidated undrained triaxial tests, and Rowe cell consolidation tests. The results of these preliminary tests are shown in Table 1.
Second stage of tests includes UCS tests on stabilized peat soils, containing various amount of ordinary Portland cement with and without polypropylene fibers. UCS tests were conducted on stabilized peat soil samples at different curing ages.
All of the stabilized peat soils samples used in this study were at their original natural moisture content of about 200% (200 ± 2%). Therefore no water was added or deducted from the natural peat soil during mixing with cement and fibers throughout the experimental study.

IV. UNCONFINED COMPRESSIVE STRENGTH TESTS

Unconfined compressive strength tests have been conducted on the undisturbed peat soil as well as stabilized peat soil. Sample size used for the experiments was 38mm diameter and 76 mm length**.** Disturbed samples used for the stabilized peat soil's UCS tests were the peat soil samples at their natural (field) moisture content. For this purpose, first the peat soil was screened in order to remove the larger size of vegetal fibers using sieve 6.3 mm (0.3″) then, specified amounts of OPC and polypropylene fibers were added to screened peat soil, mixed well for their homogeneity, and placed in steel mold having inside diameter of 38 mm. and L/D of 2, in three layers. Each layer was given 10 constant full thumb pressures of approximately 10 seconds as used in Sweden for compacting peat soil samples in their moulds described by Axelson, et. al. (2002)[9].The UCS tests were conducted for stabilized samples immediately after mixing (0 day) and after cured at ages of, 7, 28, 90, and 180 days, for different percentage of OPC with and without polypropylene fibers.

V. CURING PROCEDURE

Curing technique used to cure the stabilized peat soil samples was air curing technique described by Kalantari, and Huat (2008). In this technique, as soon as the stabilized peat soil samples were formed, they were wrapped in plastic sleeves, and kept in normal air temperature of 30 ± 2 ºC and out of reach of water intrusion during the curing period, as shown in Figure 5.

VI. MIXTURE DOSAGE RATES

The amounts of ordinary Portland cement (OPC) used in this research for the unconfined compressive strength (UCS) test samples were, 5, 15, 20, 30, and 50%. As an example, 5% cement means that for each 100 g of wet peat soil (soil with natural moisture content of 200%), 5 g of OPC in powder form were added.
Amount of polypropylene fibers used in this study was 0.15%, and it was based on the finding of Kalantari, and Huat (2008)[2] for optimum dosage rate of fibers when used with cement, and peat soil.

VII. RESULTS AND DISCUSSION

Results shown on Fig. 3 indicate that; as the curing period is increased, the w/c ratios (weight of water divide by the weight of water) for all the samples containing different amount of cement are decreased.
Results from Figure 4, indicate that, as the w/c ratios for different types of stabilized peat soil samples are decreased through curing periods, the UCS values for are increased.
Results shown on Fig. 5 indicate that UCS values of three months, as well as six months samples for stabilized peat soil samples containing 5% cement are increased when polypropylene fibers are added to the mixture of peat and cement.
Results obtained from Figures 6, 7, 8, and 9, that are comparison of UCS values of stabilized peat soil with cement alone, and also when polypropylene fibers are used in the stabilized peat soil samples containing different amounts of polypropylene fibers, show that strength values of stabilized peat soil samples with fibers are more than those samples that contain only ordinary Portland cement.

VIII. CONCLUSION

In this laboratory study, different types of stabilized peat soil containing various amounts of ordinary Portland cement (OPC) alone as well as stabilized peat soil samples with OPC and polypropylene fibers. Curing procedure used for the samples was air curing technique that is to keep the stabilized peat soil samples in air and out of water intrusions during the curing period. Curing periods used for the samples stats with the zero day (immediately after forming the samples), 7, 28, 90, and 180 days. The strength values of different type of stabilized peat soils samples have been evaluated by UCS tests.
Results obtain indicate that, air curing technique used to cure the stabilized peat soil samples, caused the samples lose some of their moisture contents during the curing periods, and as the samples lost water, their w/c ratios reduced, and as a result their UCS values increased. The strength gain for the stabilized peat soils with OPC as well as with fibers continued through three and six months curing periods, and beyond 28 days. Also, when polypropylene fibers are added to the stabilized peat soil samples containing 5, 15, 20, 30, and 50% OPC, unconfined compressive strength values of the samples at 28, 90, and 180 days of curing age increase compared with the samples that contained only ordinary Portland cement.

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Figure 1: Polypropylene fibers

Figure 2 Plastic wraped peat samples are their air curing condition

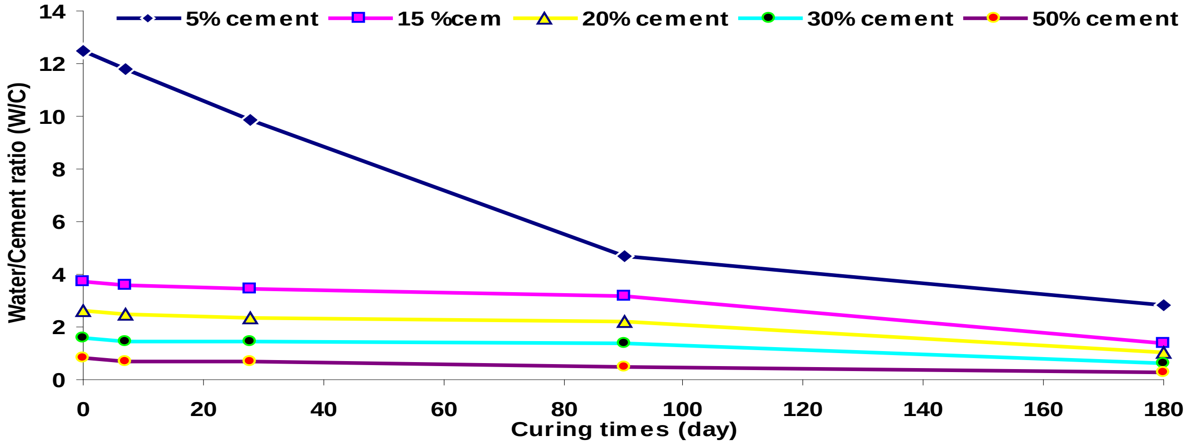

Figure 3;Water cement ratios vs.curing time for peat soil mixed with various amount of cement

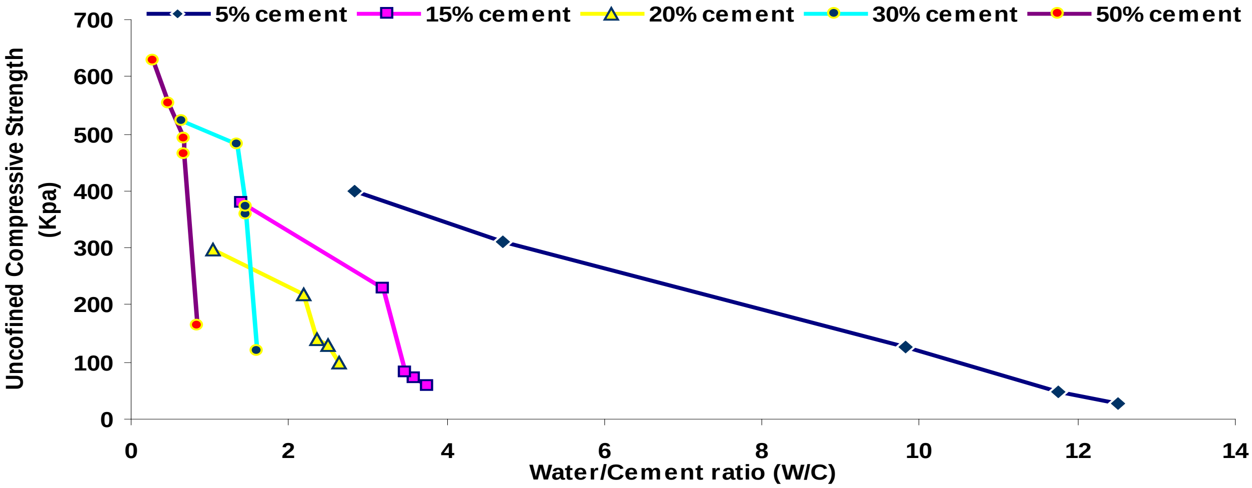

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Figure 4; Unconfined compressive strengths vs.water cement ratio for peat soil mixed with various mounts of cement

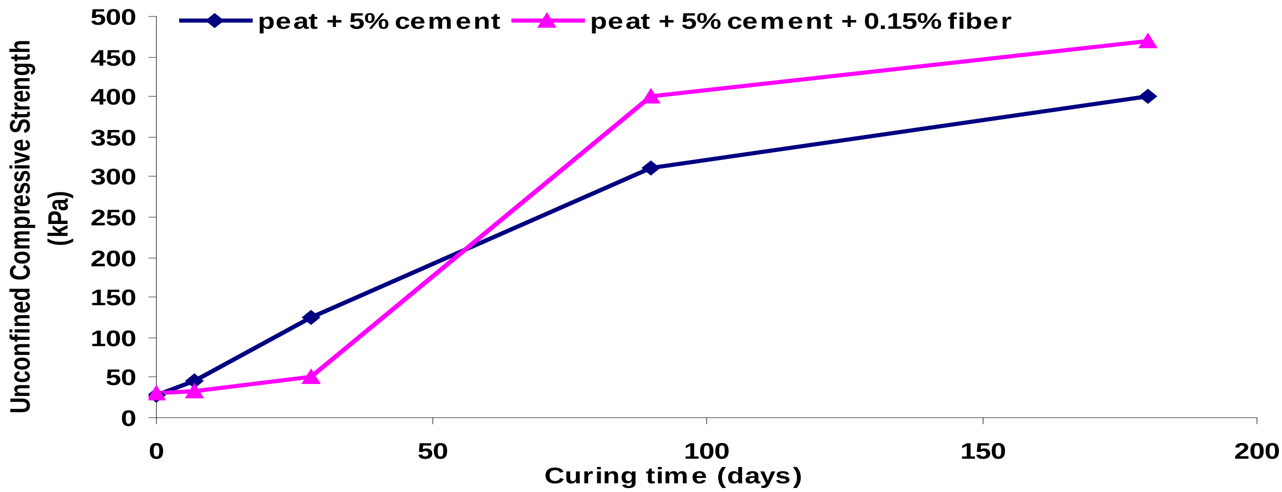

Figure 5; Unconfined compressive strength values for peat and 5% cement as well as for peat, 5% cement,and fibers vs. curing time

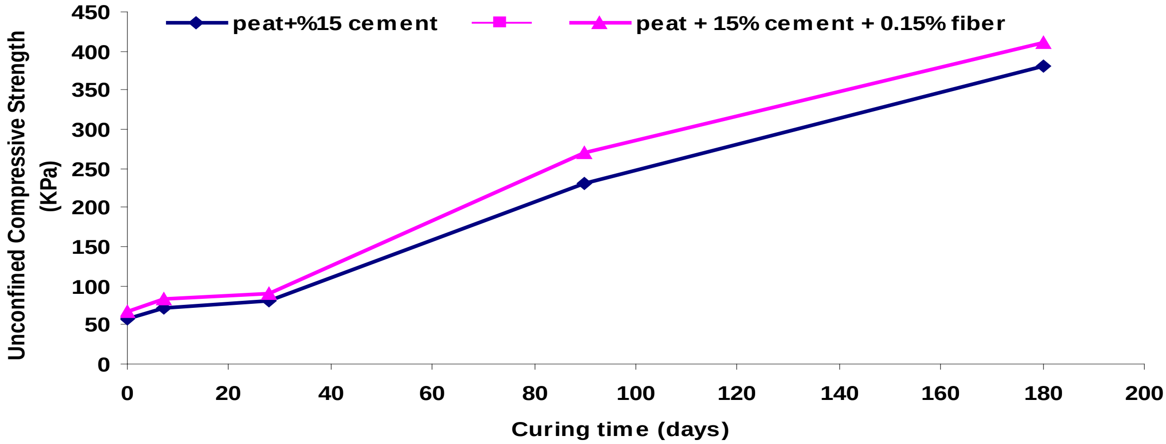

Figure 6;Unconfined compressive strength values for peat and 15% cement as well as for peat, 15% cement,and fibers vs. curing time.

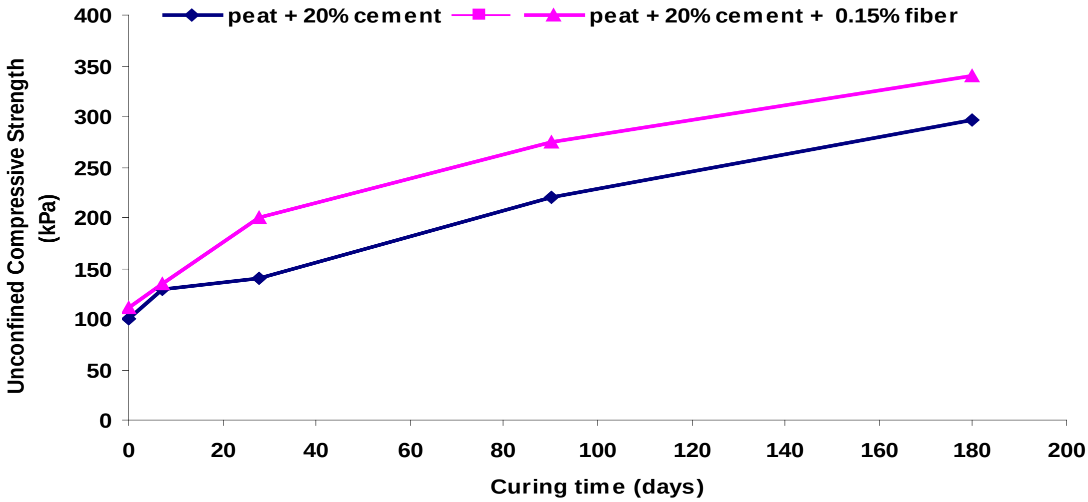

Figure 7;Unconfined compressive strength values for peat and 20% cement as well as for peat, 20% cement, and fibers vs. curing time

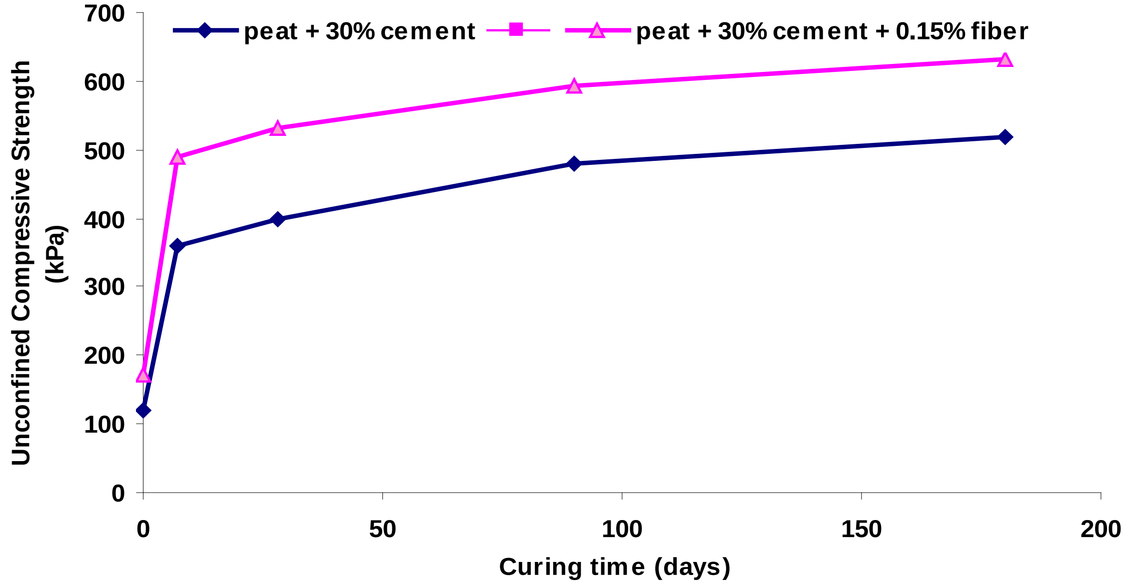

Figure 8; Unconfined compressive strength values for peat and 30% cement as well as for peat, 30% cement, and fibers vs. curing time

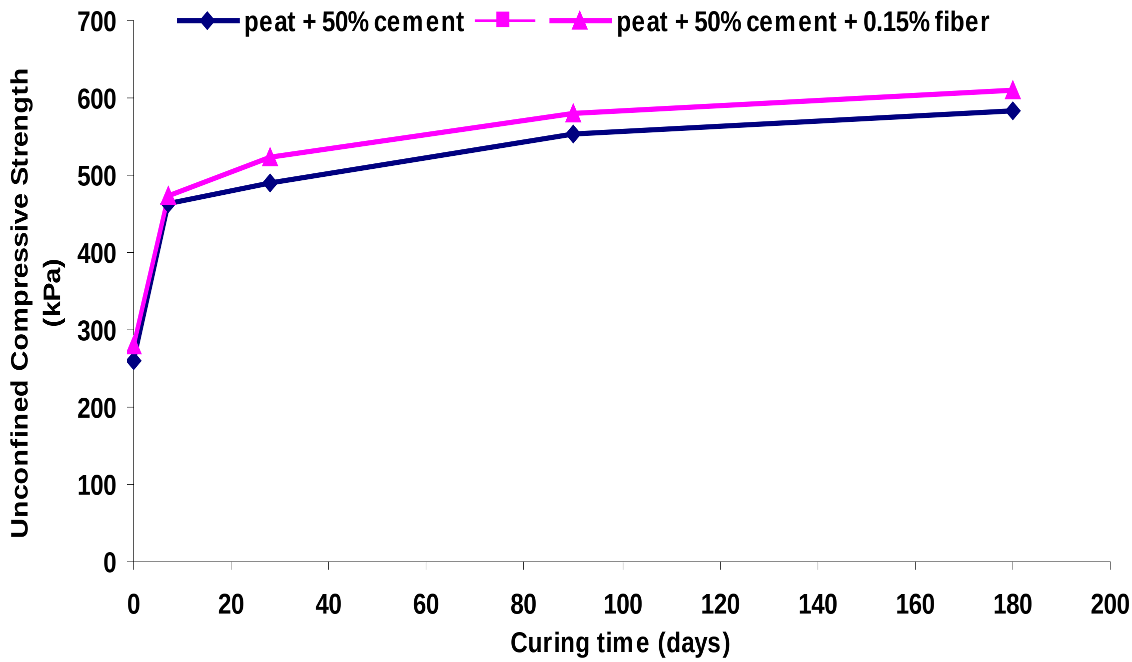

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Figure 9; Unconfined compressive strength values for peat and 50% cement as well as for peat, 50% cement, and fibers vs. curing time

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Influence of Lime and Plastic Jute on Strength and CBR Characteristics of Soft Clayey (Expansive) Soil

GJRE Classification (FOR)
090503, 090506, 040204 & 040306

D. Neeraja[α]

Abstract-Growing urban developments have intensified the demand for housing and roads resulting in densification of land use. As a result, structures have been constructed in agricultural areas that have been converted as residential colonies. Theses soils popularly known as expansive soils pose several problems to the structures. Improvement of such soil has been observed by adopting various techniques like soil stabilization, adoption of reinforcement etc. Generally admixing technique in soil has an effective ground improvement because of its easy adaptability. It is well known that lime is an effective agent to be mixed with fine grained soils with high plasticity and it improves certain properties of the soil due to its chemical action. In order to reduce the brittleness of soil stabilized by lime only, a recent study of a newly proposed mixture of plastic jute fiber and lime for ground improvement is reported in this paper. In this paper, an optimum value of percentage of lime to be added along with different proportions of plastic jute to improve the properties of the soil is recommended. The effect of lime on the engineering properties such as Optimum Moisture Content (OMC), Maximum Dry Density (MDD), Unconfined Compressive strength (UCC), California Bearing Ratio (CBR) was studied on different samples. Soil samples were tested with 0%, 0.5%, 0.65%, 0.8%, and 1.0% plastic jute fibers cut to 25mm size by dry weight. Based on the favorable results obtained, it can be concluded that the expansive soil can be successfully stabilized by the combined action of jute fiber and lime.

Keywords: California Bearing Ratio, Compaction, Lime, Plastic Jute, Unconfined Compressive strength

I. Introduction

Some partially saturated clayey soils are very sensitive to variations in water content and show excessive volume changes. Such soils, when they increase in volume because of an increase in their water contents are classified as expansive soils. It would be ideal to find a soil at a particular site to be satisfactory for the intended use as it exists in nature, but unfortunately, such a thing is of rare occurrence. So it is very important for the engineer to know about the extent to which soil properties may be improved or to think of other alternatives for the construction of intended structure at the available site. One method of controlling volume changes is to stabilize soft clayey soils with admixtures that prevent volume changes or adequately modify the volume change characteristics of soft clayey soil (Kehew 1995). Soil improvement results not only in improvement of strength and ground water condition but also in improvement of permeability, compressibility etc., With the reduction of available land resources, more and more construction of civil engineering structures is carried out over weak or soft soil, which leads to the establishment and development of various ground improvement techniques such as soil stabilization and reinforcement Lime stabilization has been extensively applied in practice of civil engineering such as foundations, roadbeds, embankments and piles (Ye and Ye, 1999). When lime is added to soils, it reacts with soil particles, which leads to the improvement in many engineering properties of soils. Some investigators found that the strength behavior of soils was greatly improved after lime treatment (Balasubramaniam et al., 1989; Locat et al., 1990, 1996; Narasimha Rao and Rajasekaran, 1996). The work of Bell (1996) indicated that soils treated with lime experienced notable increase in optimum moisture content while undergoing a decrease in maximum dry density. Rajasekaran and Narasimha Rao (1996), reported that the strong cementation bonds between soil particles, brought by lime–soil reactions, could resist the forces applied effectively, which resulted in the reduction of compressibility of marine soils.

Soil stabilization is a procedure where natural or manufactured additives or binders are used to improve the properties of soils. There are several methods that have been used to minimize or eliminate the harmful effects of expansive/soft clayey soils on structures. These methods include chemical stabilization, soil replacement with compaction control, prewetting, moisture control, surcharge loading, and use of Geosynthetics. Chemical additives, such as lime, cement, fly ash, and other chemical compounds have been used in expansive soil stabilization for many years with various degrees of success (Al-Rawas, 2002).In recent years, discrete fibers have been added and mixed into soils to improve the strength behavior of soils (Mandal and Murti, 1989) reported that there were notable increases in shear strength, toughness and plasticity of a cohesive soil after reinforcement with discrete *polypropylene fiber*. In addition, some investigators found that the use of discrete fiber increased toughness significantly and led to further improvement of the strength behavior of soil. However, the reports on the use of discrete fiber for improving the toughness and strength of lime-stabilized soils have not been seen yet. Thus, an attempt to admix plastic jute fiber and lime to soils for ground improvement was made in this paper.

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admix plastic jute fiber and lime to soils for ground improvement was made in this paper.

II. MATERIALS AND METHODS

Soil

The soil used in this study was obtained from Gajulamandyam near Tirupati. Disturbed but representative soils were collected from trial pits at a depth of about 2.0m from ground level. The soil collected from the site was pulverized with wooden mallet to break lumps and then air-dried. Subsequently it was sieved through 2.36 mm IS sieve and then dried in an oven at 105^0C for 24 hours The properties of the soil along with classification are presented in Table1. The soil falls under the CH category i.e., clay of high compressibility as per I.S Classification System (IS 1498-1970). The fine fraction has very high Liquid Limit and Plasticity Index. Based on Differential free Swell Index, Liquid Limit and Plasticity Index of the soil, the soil comes under the category of High degree of Expansiveness (IS 1498-1970).

TABLE 1. Properties of Soil

CHARACTERISTICS	VALUE
Specific gravity	2.69
Particle Size distribution	
a) Gravel (%)	Nil
b) Sand (%)	12
c) Silt+Clay (%)	88
Liquid limit (%)	98
Plastic limit (%)	13
Plasticity index (%)	85
Differential Free Swell Index (%)	150
Classification of soil	CH
Maximum dry density (KN/m^3)	17.99
Optimum moisture content (%)	14
Unconfined Compressive Strength (kN/ m^2)	145
Unsoaked CBR (%)	7

Lime

The percent lime added was determined from ASTM D 6276. The soil and lime were dry mixed together and then water was added to bring the moisture content up to the target per cent. Due care was taken to ensure a uniform soil-lime mixture. The soil- lime mixture was placed in an airtight container to mellow overnight.

Jute Geo-textile

Jute Geo-Textile (JGT) is a kind of natural technical textile laid in or on soil to improve its engineering properties. It is made out of yarns obtained from the jute plant. Jute Geo Textiles have high moisture absorption, excellent durability, high initial tensile strength and bio-degradable. The basic functions of JGT are separation, filtration, drainage and initial reinforcement. JGT can be more effective, eco-friendly and economical if used judiciously and jointly with other materials.

III. TESTS CONDUCTED

The compaction tests on unreinforced and reinforced soil-lime-jute mixes were conducted in accordance with I.S.2720:1980.UCC tests were conducted in accordance with I.S.2720:1973. CBR tests were conducted in accordance with I.S.2720:1979. The test results of untreated soil sample are given in Fig 1, Fig 2, and Fig 3.

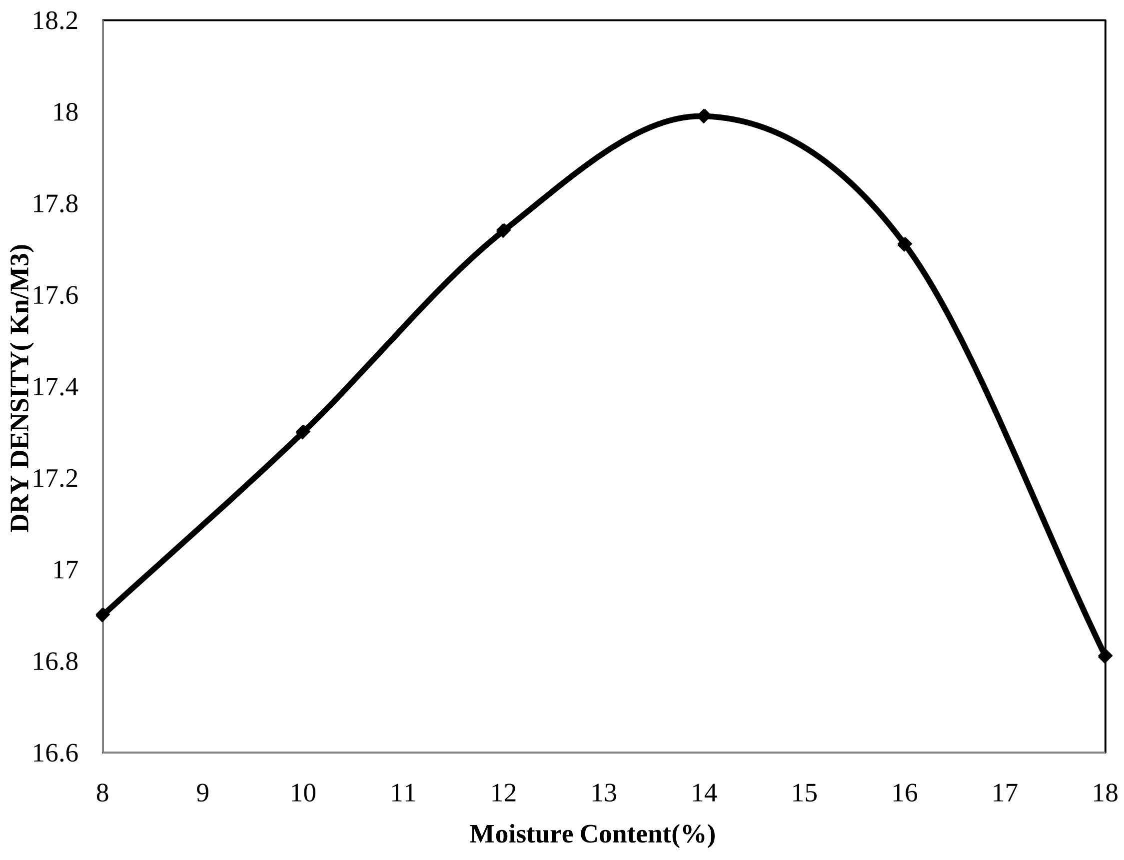

Fig 1.Compaction Curve For Untreated Soil

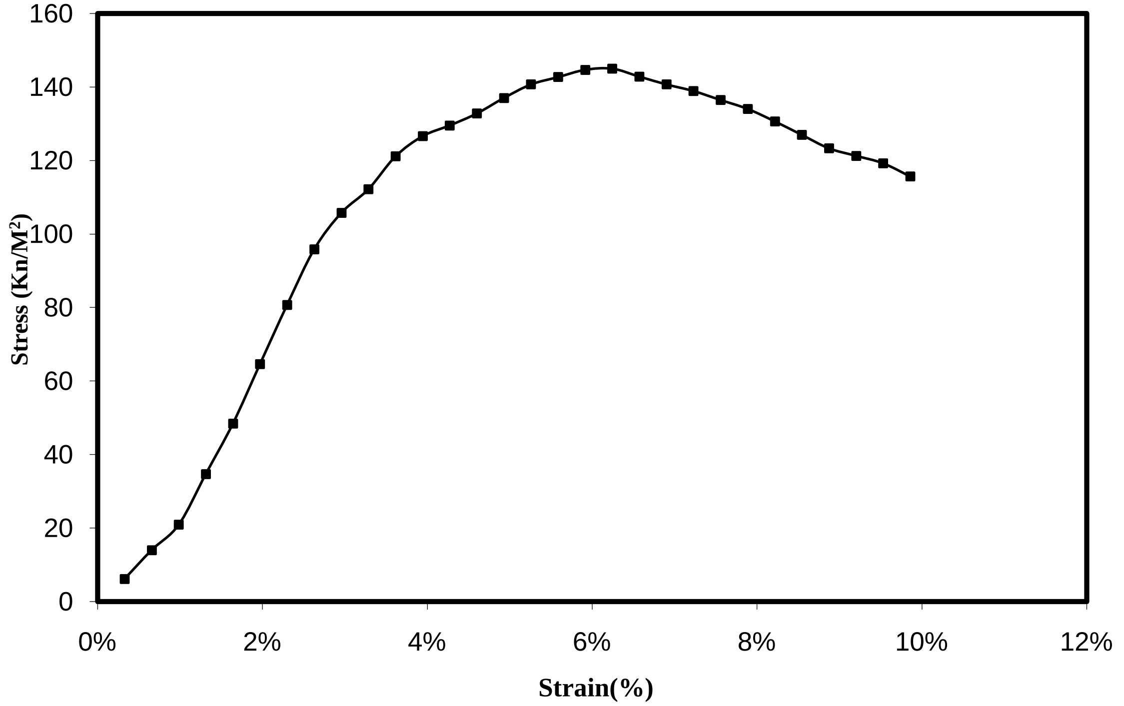

Fig 2.Stress-strain Plot Of Untreated Soil

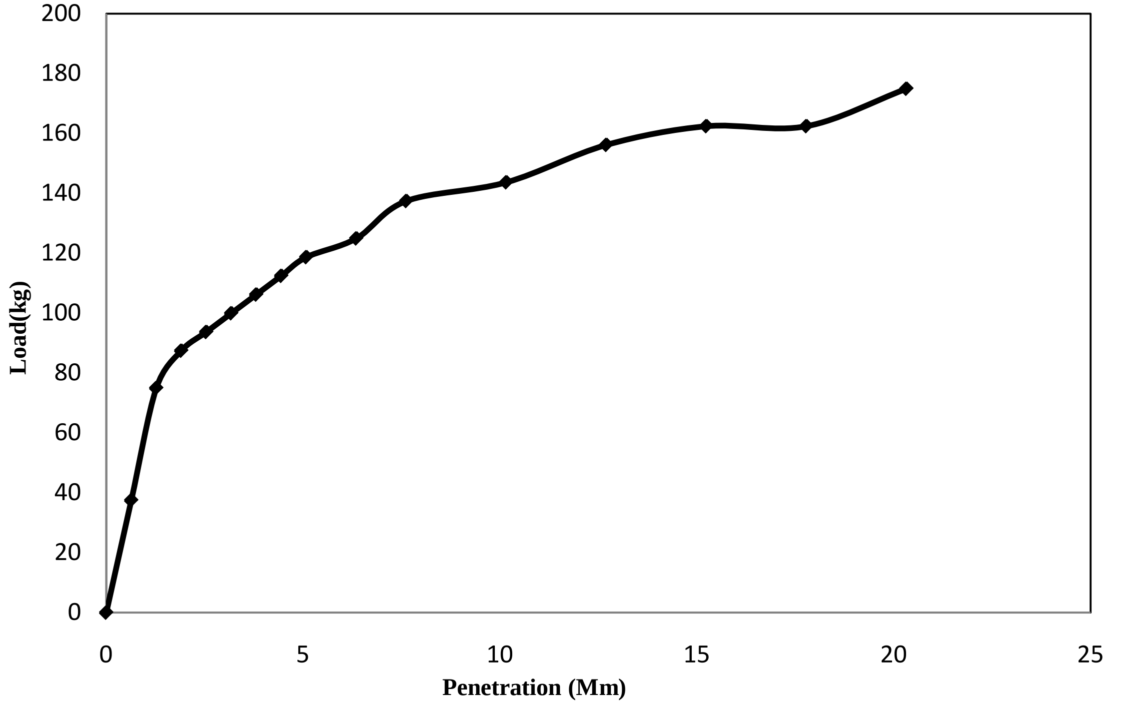

Fig 3. Load Vs Penetration Curve Of Untreated Soil

IV. Results and discussion

A. *Compaction parameters*

For a given lime content, in the compaction tests, addition of lime decreased the maximum dry density of the stabilized soil but increased the optimum moisture content (Fig 4). Earlier studies had also observed that the addition of lime leads to an immediate decrease in the maximum dry density of soil and an increase in the optimum moisture content, for the same compactive effort. The decrease in the maximum dry density of the treated soil is reflective of increased resistance offered by the flocculated soil structure. The increase in optimum moisture content is probably a consequence of additional water held within the flocculated soil structure resulting from lime interaction. This trend does not change even after the addition of plastic jute. Fig-5 clearly shows that an increase in plastic jute content results in a decrease of maximum dry density and increase in optimum moisture content. Jute, which has a low specific gravity, when present in excess of the amount required for reaction with the available lime may have reduced the dry density. Increase in moisture content is probably due to additional water being absorbed by the excess lime

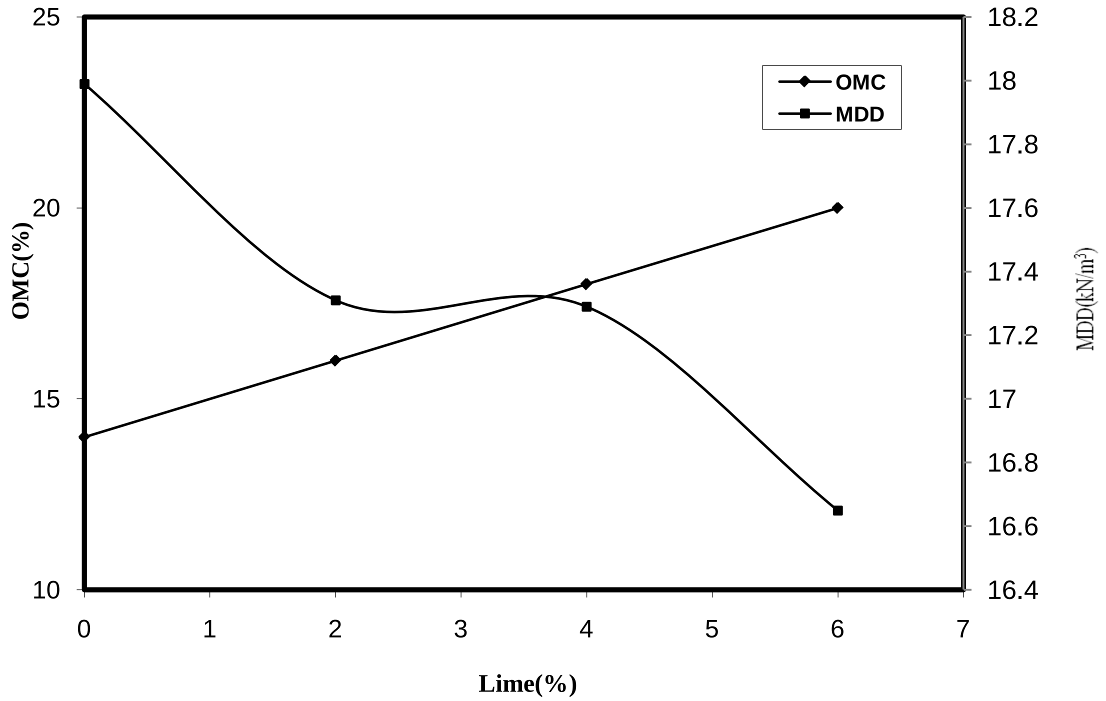

Fig 4.Variation Of Omc And Mdd With Per Cent Lime

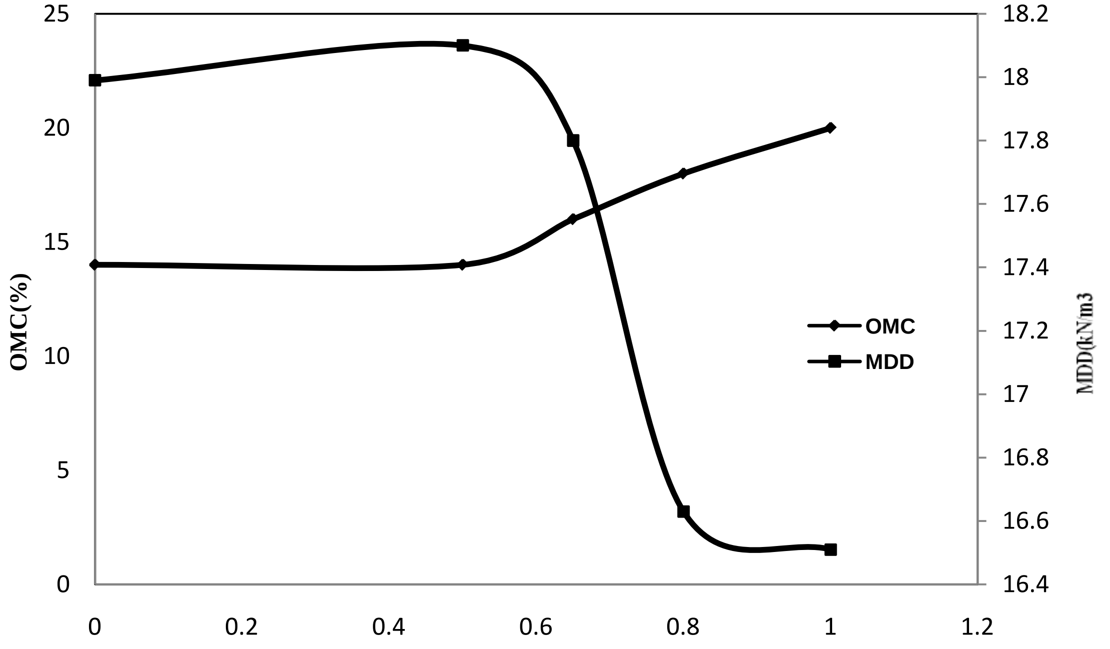

Fig 5.Variation Of Omc And Mdd With Per Cent Plastic Jute+5% Lime

B. *Unconfined Compressive Strength*

general pattern is observed in which the strength develops rapidly with addition of lime until an optimum condition is reached, beyond which the increase in strength is either nominal or there is marginal decrease in strength. The optimum lime content is observed to be about 5 % in all the unconfined compressive strength soil samples (Fig 6). Maximum UCC value obtained was 257.94 kN/m^2 at 5% lime content. Although treatment with lime improves the strength characteristics of soil, addition of plastic jute further improved the strength of the lime-stabilized soil. For example, at 5 % lime content and 0.65% plastic jute the maximum compressive strength obtained was 310.15 kN/m$^{2.}$ This indicates that in lime –soil mixture, a lesser amount of jute is required to achieve more strength when compared to lime – soil mixture. The gain in strength of lime stabilized soil is primarily a result of pozzolanic reactions between silica and alumina from the soil and lime to form various types of cementing agents. By introducing lime to the soil, additional amounts of silica are available
for reaction with jute resulting in further increase of strength. Presence of jute in the soil lime mix beyond the optimum value does not lead in strength development. The reason may be attributed to the insufficient availability of jute for pozzolanic reaction. Since jute is much cheaper than lime, addition of plastic jute in lime-soil mix can result in cost reduction of construction. In tropical countries where plastic jute is abundant and considered as waste material, use of plastic jute in the construction of roads, airfields and other earthworks may particularly become attractive, because of reduced construction costs, reduced disposal costs and environmental damage and conservation of high grade construction materials.Fig7. Shows the relationship between stress-strain plots of soil admixed with combination of 5% lime and various percentages of plastic jute. It can be seen that addition of plastic jute produces not only higher strength but also higher rate of initial strength development. Plastic jute with the optimum values produced increase and reduction at the later stage. Earlier research also indicated that for lime stabilized
soil, the strength increases rapidly at first followed by a reduced and more or less constant rate. This supports the view that cementations products are formed at an early stage, that is, as soon as flocculation is completed due to limeclayreaction

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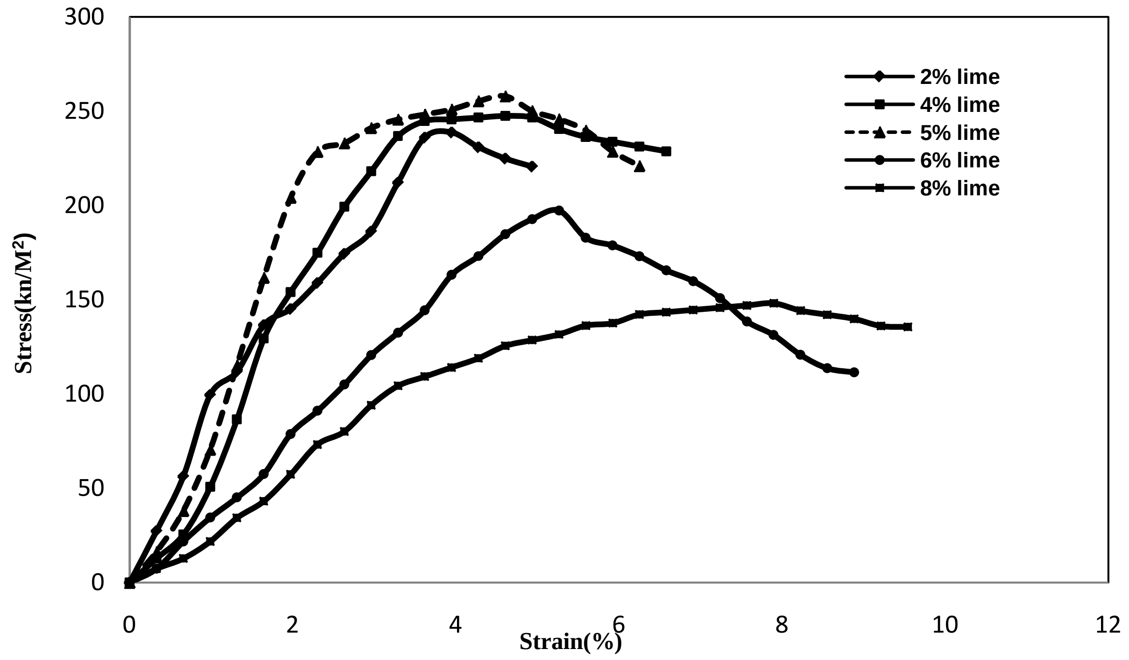

Fig 6.Stress-strain Plots Of Soil Admixed With Lime

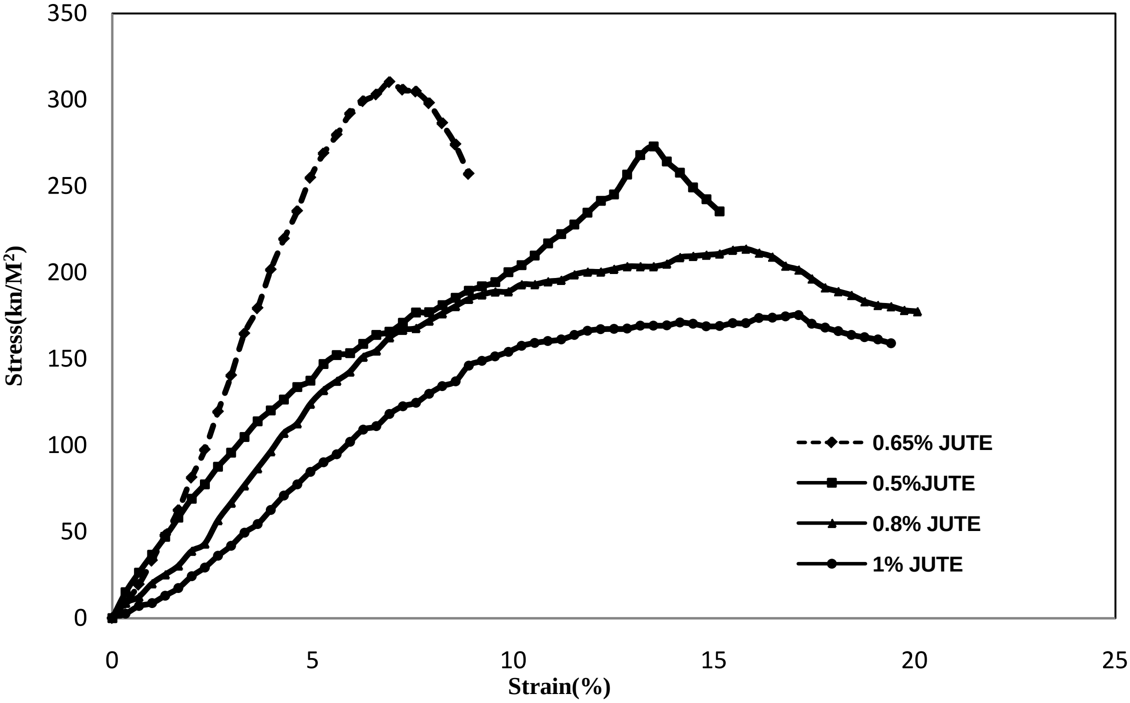

Fig 7.Stress-strain Plots Of Soil Admixed With Percent Plastic Jute+5% Lime

C. *California Bearing Ratio*

Fig. 8 shows the results of CBR test at 5% lime content. CBR value at 5% lime is 12.24%. It can be observed from the Fig. 9 that addition of 5% lime and plastic jute increased the CBR value considerably. CBR value at 5% lime and 0.65% plastic jute was 20%. Information available from literature indicates that CBR value of soil increased significantly after the addition of lime. Addition of plastic jute further enhanced the CBR value. The increase in CBR value after addition of lime and plastic jute is due to the formation of various cementing agents due to pozzolanic reaction between silica present in soil and lime. When plastic jute was added, additional amount of silica became available for reaction with lime, which further increased the CBR value. Therefore the efficiency of lime stabilization may be greatly increased by the addition of plastic jute. For all the proportions of plastic jute contents considered in the study, addition of 5% lime and 0.65% plastic jute was found to be optimum for maximum improvement in CBR which gave a CBR value of 20.97%.

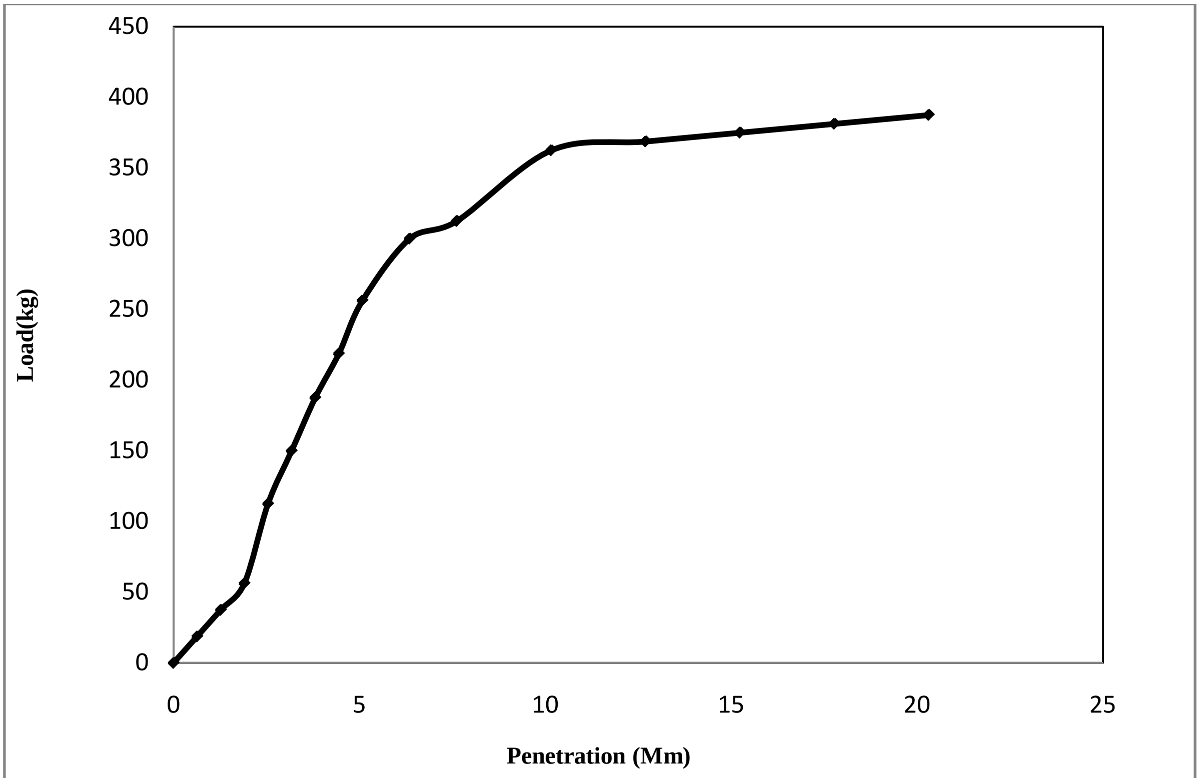

Fig 8. Load Vs Penetration Curve Of Soil Admixed With 5%lime

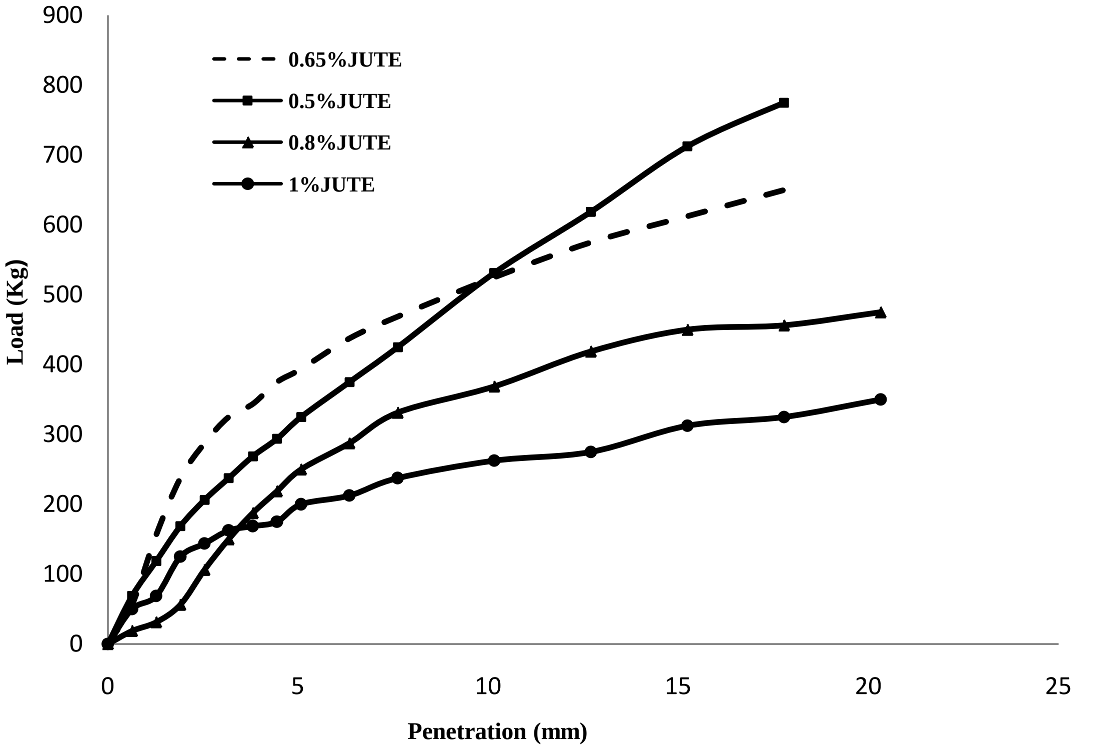

Fig 9. Load Vs Penetration Curve Of Soil Admixed With Per Cent Plastic Jute +5% Lime

V. Conclusions

On the basis of present study, the following conclusions can be drawn:

1. With the increase in lime content and increase in plastic jute content with fixed lime content, MDD decreases and OMC increases.
2. Addition of plastic jute content with 5% lime content increased UCC and CBR values.
3. The optimum value for plastic jute content may be taken as 0.65% at a lime content of 5%.

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Optimal Location of FACTS Devices In Power System by Genetic Algorithm

K. Lokanadham[α]

GJRE Classification (FOR)
090602, 090604, 090607 & 090609

Abstract: **This paper presents one of the heuristic methods i.e. a Genetic Algorithm to seek the optimal location of FACTS devices in a power system. The optimizations are performed on three parameters: the location of the devices, their types and their values. Four different kinds of FACTS controllers TCSC, TCPST, TCVR and SVC are used and modeled for steady-state studies. Results from simulation show the difference of efficiency of the devices used in this paper. They also show that the simultaneous use of several kinds of controllers is the most efficient solution to increase the power system performance. We observe the maximum number of devices beyond which this system performance cannot be improved.**

I. Introduction

Since the 1970's, energy cost, environmental restrictions, right -of -way difficulties along with other legislative social and cost problems have postponed the construction of both new generation and transmission systems in India as well as most of other countries. Recently because of adoption of power reforms or restricting or deregulation, competitive electric energy markets are being developed by mandating into a separation of generation and transmission is taking progressively; at last, every consumer will be able to buy his own electricity from any desired source (*Third Party Access*). The Western Europe countries like Chile, UK, Norway or the USA have already set off on the way to the liberalization. [1], but in every case the economical effects: i) a price decrease of the KWH particularly for large customers, and ii) a reductions of the disparities in regional costs are same on the technical side. An increase of the unplanned power exchanges due to the competition among utilities and to contracts concluded directly between producers and consumers. If the exchanges were not controlled, some lines on particular paths located may become overloaded called *congestion*, and full capacity of transmission interconnections could not be utilized. In deregulated environment, this kind of control seems to be not possible any more. Parallel to the deregulation, electrical load carries on increasing. Of course this growth has been practically stabilized in developed nations, but some transmission lines are already close to their thermal limit. Therefore it is attractive for electrical utilities to have a way of permitting a more efficient use of the transmission lines by controlling the power flows.

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Appearance of FACTS devices (*Flexible AC Transmission Systems*) opens up new opportunities for controlling power and enhancing the usable capacity of existing transmission lines. For a meshed network, an optimal location of FACTS devices allows to control its power flows and thus to increase the system load ability. However, a limit number of devices, beyond which this load ability cannot be improved, has been observed [2].

In this paper, four different types of devices, with specific characteristics, have been selected and modeled for steady-state analysis. They are used in the power transmitted by the network to be maximum by controlling the power flows. The optimal location of a given number of FACTS is a problem of combinatorial analysis. To solve this type of problem, *Genetic Algorithms* (GAs) [5] have chosen.

II. FACTS devices

A. *Generalities on FACTS Devices*

In a power system, FACTS devices may be used to achieve several goals. In steady-state, for a meshed network, they can permit to operate transmission lines close to their thermal limits and to reduce the loop flows. In this respect, they act by supplying or absorbing reactive power, increasing or reducing voltage and controlling series impedance or phase-angle. Their high-speed command gives them several qualities in dynamic stability. In particular, they are capable

to increase synchronizing torque, damp oscillations at various frequencies below the rated frequency (0.2 to 1.5 Hz), support dynamic voltage or control power flows. Moreover, FACTS devices may have benefits in case of short circuits, by limiting short-circuit current [3], [4].

Another advantage of FACTS devices consists in the fact that this technology gives the opportunity to extend the current transmission line limits in a step-by-step manner with incremental investment when required. Different types of devices have been developed and there is various ways to class them: i) the technology of the used semiconductor, ii) the possible benefits of the controllers, and iii) the type of compensation.

According to the last classification, can be divided in to four categories of FACTS controllers:

- Series controllers
- Shunt controllers
- combined Series-Shunt controllers
- combined Series-Shunt controllers

Several FACTS devices exist and each one has its own proprieties and may be used in specific contexts.

B. Choice of FACTS Devices

In an interconnected electrical network, power flows obey Kirchhoff's laws. Usually, the value of the transverse conductance is close to zero and for most transmission lines, the resistance is small compared to the reactance. By neglecting the transverse capacitance, active and reactive power transmitted by a line between two buses 1 and 2 may be approximated by the following relationships:

$P_{12} = (V_1 V_2 / X_{12}) \text{ Sin } \theta_{12}$ . . . . (1)

$Q_{12} = (1/X_{12}) (V_1^2 – V_1 V_2 \text{ Cos } \theta_{12})$ …(2)

Where

V_1 and V_2 Voltages at buses 1 and 2;
X_{12} is the reactance of the line;
θ_{12} is the angle between V_1 and V_2 .

Under normal operating conditions for high voltage lines $V_1 \approx V_2$ and θ_{12} is typically small.

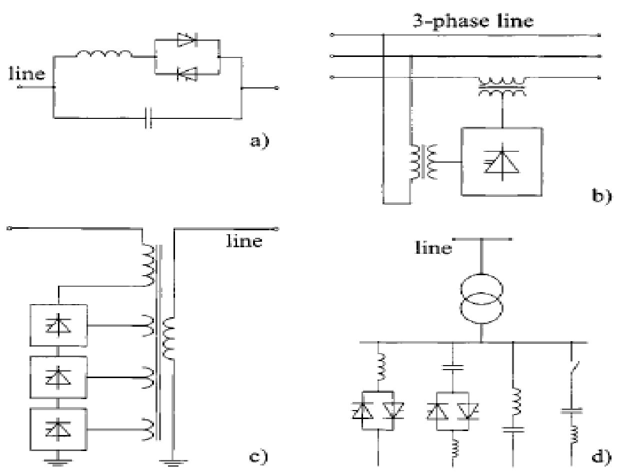

Fig.1: (a). TCSC, (b). TCPST, (c). TCVR, (d). SVC

Four different types of devices have been chosen to be optimally located in order to control power flows (Fig.1). Each of them is able to change only one of the above three mentioned parameters. The first one is the **TCSC** (*Thyristor Controlled Series Capacitor*), which permits to decrease or increase the reactance of the line. To control the phase-angle, the **TCPST** (*Thyristor-Controlled Phase Shifting Transformer***)** has been selected. The **TCVR** (*Thyristor-Controlled Voltage Regulator*) is picked up to act principally on. Finally, the **SVC** (*Static Var Compensator*) is used to absorb or inject reactive power at the midpoint of the line.

C. . Modeling of FACTS Devices

The models of the FACTS devices are developed to be suitable for steady-state. Each device may take a fixed number of discrete values.

TCSC is modeled with three ideal switched elements in parallel: a capacitance, an inductance and a simple wire, which permits the TCSC to have the value zero. The capacitance and the inductance are variable and their values are function of the reactance of the line in which the device is located. In order to avoid resonance, only one of the three elements can be switched at a time. Moreover, to not overcompensate the line, the maximum value of the capacitance is fixed at -0.8 X_L**.** For the inductance, the maximum is 0.2 X_L.

The TCPST acts by adding a quadrate component to the prevailing bus voltage in order to increase or decrease its angle. The model used for this device is an ideal phase shifter with series impedance equal to zero. It is inserted in series and may take values of angles comprised in the range of -5 deg to +5 deg. Zero is also a possible value for the TCPST.

The TCVR operates by inserting an in-phase voltage to the main bus voltage so as to change its magnitude. As model for this controller, we use an ideal tap changer transformer without series impedance. The value of the turn's ratio is given by the ratio. It determines the additional transformation relative to the nominal transformation and its values range from 0.9 to 1.1 (1.0 corresponds to no additional transformation).

SVC is modeled with two ideal switched elements in parallel: a capacitance and an inductance. It may take values characterized by the reactive power injected or absorbed at the voltage of 1 p.u. The values are between -100 MVar and +100 MVar.

A graphical representation of the above-described models is shown in Fig. 2.

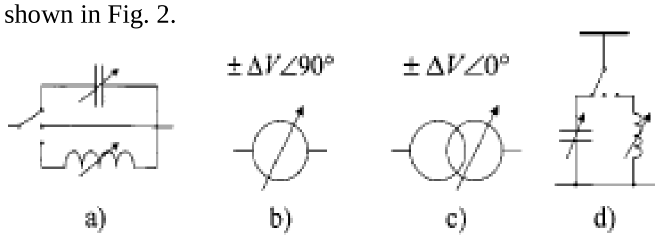

Fig.2: (a). TCSC, (b). TCPST, (c). TCVR, (d). SVC

Only one FACTS device per line may be allowed. For the TCSC, TCPST and TCVR, the devices are directly integrated into the model of the line. They are inserted in series with the

resistance and the reactance of the line. For the SVC, the line is split into two equal parts and the device is inserted in the middle.

III. Optimization Algorithms

A. *Description of the Used Genetic Algorithm*

The goal of the optimization is to find the best location of a given number of FACTS devices in accordance with a defined criterion. A configuration of FACTS devices is defined with three parameters: the location of the devices, their types and their values.

In order to take into account the three aforementioned parameters in the optimization, a particular coding is developed. An individual is represented with three strings of length , where is the number of devices to locate optimally.

The first string corresponds to the location of the devices. It contains the numbers of the lines where the FACTS are to be located. Each line could appear at maximum once in the string. The order of the lines in the string is not important for a given configuration, but could have its importance when applying the operator of crossover. Note that the number of the line is related with the order of the branches in the description file of the power system.

The second string is related to the types of the devices. A value is assigned to each type of modeled FACTS device: 1 for TCSC; 2 for TCPST; 3 for TCVR, and 4 for SVC at the midpoint of the line. By this way new other types of FACTS may be easily added.

The last string of the individual represents the values of the devices. It can take discrete values contained between 0 and 1; 0 corresponding to the minimum value that the device can take and 1 to the maximum. According to the model of the FACTS, the real value of the device is calculated with the relation:

$$V_{real\ F} = V_{min\ F} + (V_{max\ F} - V_{min\ F})V_F \quad ....(3)$$

where $V_{min\ F}$ and $V_{max\ F}$ are respectively the minimum and the maximum setting value of the device, and V_F is the its normalized value.

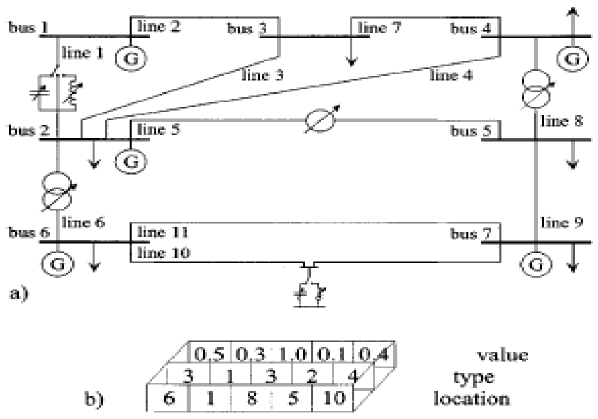

Fig.3: Configuration of 5 FACTS Devices (a). Power System, (b). Individual.

Fig.3 gives an example of configuration of five FACTS devices on a 7-bus, 11-branch network and the corresponding three coded strings. A TCSC is located on branch 1. Its value is a capacitance of $-0.5\ X_{L1}$, where X_{L1} is the reactance of the line. A TCPST, producing a phase shifting of -4° on the voltage, is present on branch 5. Two TCVR are located on lines 6 and 8. Their voltage transformations are respectively 1.0 and 1.1. Finally, a SVC is situated in the middle of the line number 10. It is inductive and absorbs a reactive power of 20 MVar at V=1.0 p.u.

For a given power system of n_b branches, the initial population is generated from the following parameters:

- The number of FACTS devices to be located optimally
- The different types of devices to be located
- The number of possible discrete settings for a device
- The number of individuals of the population.

The creation of an individual is done in three stages. First, a set of n_F branches of the network are randomly drawn and is put in the first string. As previously mentioned, the order of the branches is not important and different individuals may represent the same configuration of FACTS devices. After drawing the branches where the FACTS devices will be located, the next two steps consist in the attribution of the characteristics of the devices. The second string, referred to the types of the devices, is obtained by randomly drawing numbers among the selected devices. Thus, if we decide to optimally locate only one type of device, this string will contain the same character. Setting values of the devices are finally randomly drawn among the possible. To obtain the entire initial population, these operations are repeated n_i times.

Then, the objective function is computed for every individuals of the population. It represents a mathematical translation of the optimization to realize and does not have to be continuous or derivable. It has to be elaborated so as to favor the reproduction of good individuals without preventing reproduction of interesting others. In our case, the objective function is defined in order to quantify the impact of the FACTS devices on the state of the power system. It is developed in Section IV.

The move to a new generation is done from the results obtained for the old generation. A biased roulette wheel is created from the obtained values of the objective function of the current population as represented in Fig. 4. After that, the operators of reproduction, crossover and mutation are applied successively to generate the offsprings.

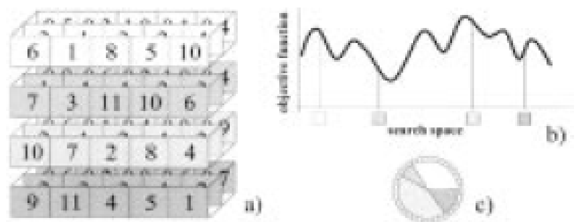

Fig.4: Computation of the Objective Function (a). Population, (b). Objective function, (c). Biased roulette wheel.

In turn, two individuals are randomly drawn from the population and reproduced. The probability of drawing an individual is proportional to its part on the biased roulette wheel. Fig. 5 shows the process of reproduction.

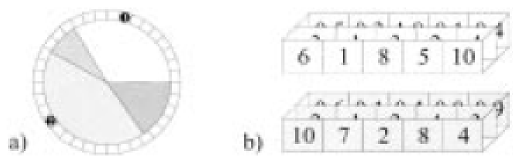

Fig5: **Reproduction (a). Draws on the biased roulette wheel (b). Selected individuals**

The crossover may occur with a probability p_c; generally close to 1. A double crossover is applied. Two crossing sites are picked up uniformly at random along the individuals. Elements outside these two points are kept to be part of the offsprings. Then, from the first position of crossover to the second one, elements of the three strings of both parents are exchanged. As previously mentioned, only one FACTS device per branch is authorized. Therefore, if the crossover leads to place a second device on a branch, a correction has to be applied. An algorithm similar to the *partially matched crossover* (PMX) is used [5]. In the case where an element of the first string already occupies a position in the kept part of the parent, it is replaced by the element corresponding to the same position in the other parent. This algorithm is repeated until an element not already present in the string is reached. Fig. 6 illustrates a crossover between two individuals.

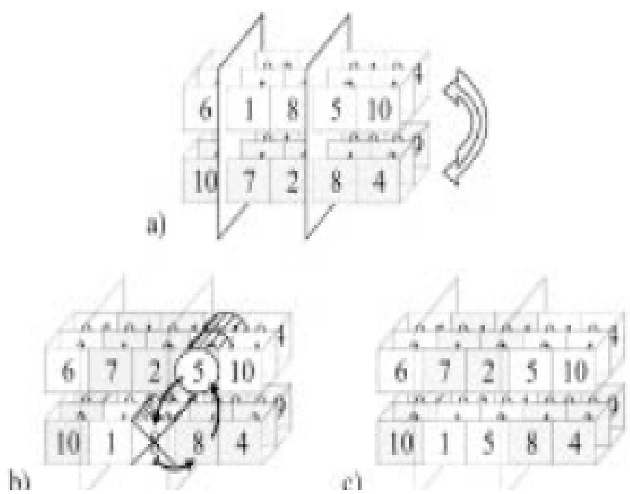

Fig.6: Crossover (a). Individuals; offsprings, (b). Before correction, (c). After correction.

A correction has to be applied on the second offspring. The element 8 is already present at the fourth position of the string. Therefore, the element 8 at the third position is replaced by the fourth element of the first parent, which corresponds to the element 5.

Mutations are possible independently on all elements of the three strings of an individual. A specific probability is applied for each string: for the first string, for the second and for the last. These probabilities change with the generations. When a mutation occurs on the first string, the one related to the location, a new line among the set of branches having no FACTS is randomly drawn. In the case of mutation on the two other strings, a new value is drawn among the set of possible ones. Examples of mutations are shown in Fig.7.

Fig.7: Mutations (a). Before mutations, (b). After mutations.

Operations of selection, crossover and mutation are repeated until the number of desired offsprings is created. The objective function is then calculated for every offsprings and the best individuals among the entire pool, comprising parents and their offsprings, are kept to constitute the new generation. By this way, the objective function of the best individual of the new generation will be the same or higher than the objective function of the best individual of the previous generation. Similarly, the average fitness of the population will be the same or higher than the average fitness of the previous generation. Thus the fitness of the entire population and the fitness of the best individual are increasing for each generation.

IV. RESULTS

A. *Objectives of the Optimization*

The goal of the optimization is to perform a best utilization of the existing transmission lines. In this respect, the FACTS devices are located in order to maximize the system loadability while observing thermal and voltage constraints. In other words, we look for increasing as much as possible the power transmitted by the network to the consumers, keeping the power system in a secure state in terms of branch loading and voltage levels.

The objective function is built in order to penalize the configurations of FACTS leading to overloaded transmission lines and over- or under-voltages at buses. Only the technical benefits of the FACTS controllers, in terms of loadability, are taken into account. Other criteria such as costs of installing and maintaining devices are not taken into account.

The objective function is defined as a sum of two terms with individual criteria. The first one is related to the branch loading and penalizes overloads in the lines. This term, called O_{vl}, is computed for every line of the network. While the branch loading is less than 100%, its value is equal to 1; then it decreases exponentially with the overload. To accelerate the convergence, the product of all objective function is taken.

The second part of the objective function concerns voltage levels. It favors buses voltages close to 1 p.u. The function is calculated for all buses of the power system. For voltage levels comprised between 0.95 p.u. and 1.05 p.u., the value of the objective function is equal to 1. Outside this range, the value decreases exponentially with the voltage deviation.

Therefore, for a configuration of FACTS devices, the objective function

C_{fg} is given by :

$$Cfg = \prod_{line} Ovl_{line} + \prod_{bus} Vtg_{bus}, \qquad (4)$$

where functions O_{vl} and V_{tg} are represented in Fig. 8. λO_{vl} and λV_{tg} are respectively two coefficients used to adjust the slope of the exponentials.

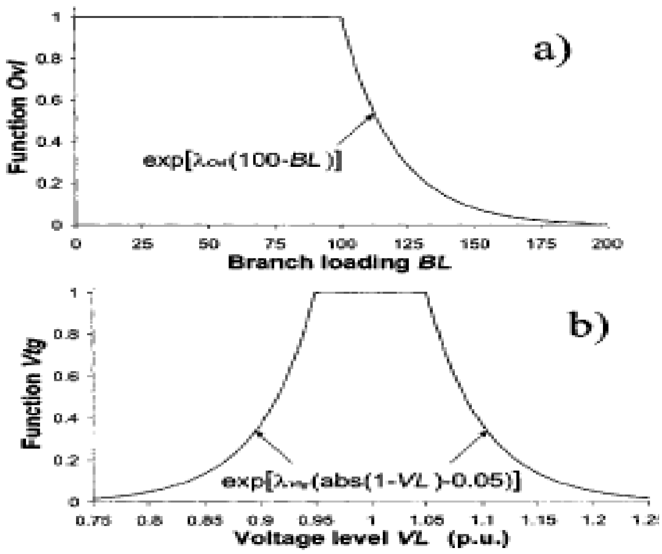

Fig.8: Objective functions (a). Function Ovl, (b). Function Vtg.

B. *Optimization Strategy*

As explained previously, the aim is to find the maximum amount of power that the power system is able to supply without overloaded line and with an acceptable voltage level. We look for locating a given number of FACTS devices to increase as much as possible the capacity of the network.

For several number of FACTS devices, we seek the best location with the best values of the most appropriate controllers. When the number of devices is increased, the results obtained previously are not taken into account. In others words, FACTS devices may disappear from specific lines to reappear on others when their number is increased.

For a given number of devices, the strategy consists of adding to the power supplied as long as a configuration of FACTS permits to keep the power system in a secure state. Starting from an initial load, the GA described in Section IV-B is applied recursively. The stop criterion is either the maximum number of generations or a solution with an objective function equal to 1. (see Section IV-A). In the first case the algorithm is stopped, otherwise the load is raised and a new optimization starts again. All loads are increased in the same proportion and real power of generators as well. Additional losses due to the increasing of the power transmitted are shared out among all the generators proportionally to their power. The whole optimization strategy is summarized in

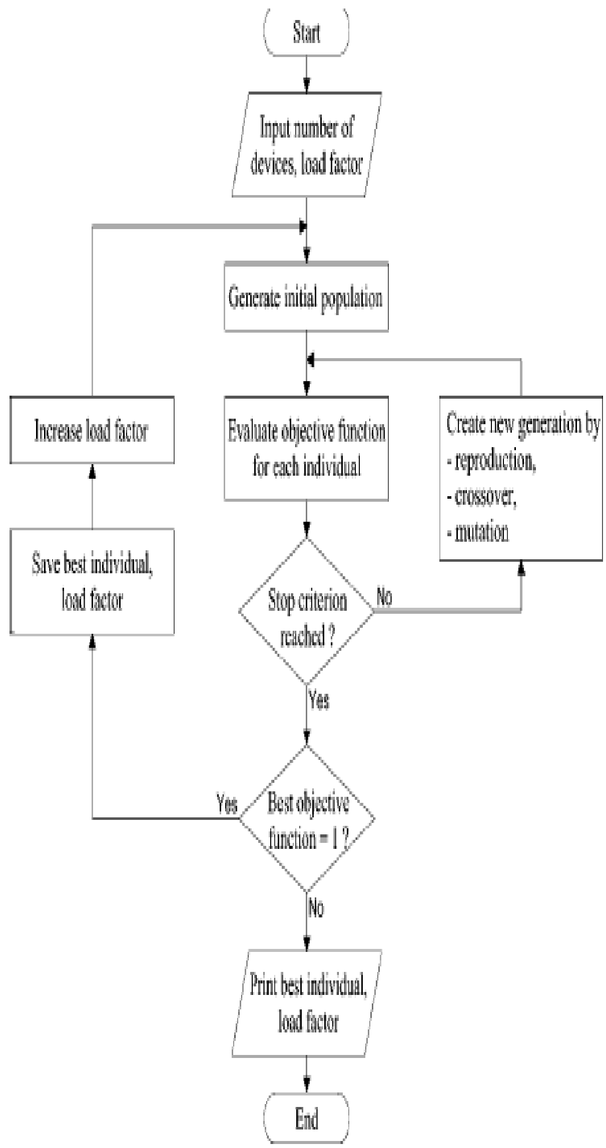

Fig.9: Flow chart of the Optimization Strategy

To compare the benefit of multi-type FACTS devices, simulations are also performed only for a single-type of device, namely TCSC, TCPST, TCVR and SVC.

V. CONCLUSION

We have presented a Genetic Algorithm to optimally locate FACTS devices in a power system. Four types of controllers were chosen and modeled for steady-state studies. Optimizations were performed on three parameters: the locations of the devices, their types, and their values. The system loadability was employed as measure of power system performance. A difference of efficiency on the loadability of the used devices has been quantified. Moreover, results have shown that the simultaneous use of several kinds of FACTS was the most efficient solution to increase the system loadability. For all the types of device, even with multi-type devices are observed once again a maximum number of FACTS beyond which this loadability cannot be improved.

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Hydraulic behaviour of dune sand bentonite mixtures under confining stress

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GJRE Classification (FOR)
090503, 090504, 090403 & 040403

Abstract-Compacted layers of sand-bentonite mixtures have been proposed and used in a variety of geotechnical projects as engineered barriers for the enhancement of impervious landfill liners, cores of zoned earth dams and radioactive waste repository systems. In the practice we try to get an economical mixture that satisfies the hydraulic and mechanical properties specified by regulation rules. The effect of the bentonite additions on the mixture is reflected by its capability of clogging the matrix pores upon swelling. In order to get an adequate dune sand-bentonite mixture, an investigation on hydraulic and mechanical behaviours is carried out in this study for different mixtures. Using oedometer test, the adequate bentonite addition to the mixture, which satisfies the conditions on permeability, is found to be around 12% to 15 %. These results are also confirmed by direct measurement using triaxial cell.

Keywords: Dune sand; Bentonite; saturated permeability; insulation barriers; south of Algeria

I. Introduction

Rapids technological advances and population needs lead to the generation of increasingly hazardous wastes. The society should face two fundamental issues, waste management and pollution risks control. One of the actual solutions, for handling these contamination problems, is by enclosing the wastes in a specific location using insulated barriers. Many different barrier materials exist, for example, plastic membranes, sand- bentonite compacted layers, cement stabilised soils [10]. The permeability of insulation barriers has been studied by many authors for different type of soil, compacted clays [6, 12], silty soils [15], mine tailings [16], and sand–bentonite mixtures [3]. The efficiency of these insulated barriers depends largely on their hydraulic and mechanical behaviour along with their abilities of contaminant retention.

Compacted sandy soils with small additions of bentonite be efficient, theses insulation barriers should fulfil some specifications: (i) the typical thickness for these layers should be between 15 and 30 cm [30]; (ii) permeability at saturated state ranges between 10-8 and 10-10 m/s [3,25]; (iii) properties of exchange and adsorption should be able to hold some preferentially polluting substances [9]; (iv) physical stability of the material in contact with water [30]; (v) a swelling potential that ensures good contact with the host rock and permits the replenishment of existing cracks or that will develop in the future; (vi) the sand should possess some characteristics of grain size distribution, in order to prevent bentonite leaching from the skeleton and hence ensuring the hydraulic stability of the mixture.

In current engineering applications, soil–bentonite mixtures are mainly used to build impervious cores of earth dams and contain groundwater pollution. Different percentages of bentonite additions are reported by many authors [20, 23, 5, 27, and 19]. Gillham [8]; Chapuis [3] have found this percentage ranges between 5 % to 8% for sodium bentonite and from 9% to 15 % for calcium bentonite.

In Algeria, the rapid development of urban areas and the growth of oil industry in the southern regions, begin to generate enormous quantities of hazardous wastes. In order to avoid groundwater pollution and environment degradation, an insulation barrier using dune sand is proposed for construction of waste disposal sites. Dune sand is an available and economical local material, enhanced by small addition of bentonite.

Generally, sodium bentonite is used more extensively than calcium bentonite because of its superior swelling potential and hence results in a low hydraulic conductivity of the mixtures [26], however it is less available through the world, instead the calcium bentonite is used in the study, which brought from the region of Maghnia in the west of Algeria.

In searching for an adequate mixture, an investigation study is carried out on several_mixtures with different percentages of bentonite additions, which varies between 3 % to 15 %. The adequate bentonite addition to the mixtures, which satisfies the required conditions on the permeability, is obtained using oedometer test. Than after, the hydraulic conductivity under confining stress and different pressures gradient is investigation with direct methods using triaxial cell. The measurements of permeability is conducted under two modes, permanent (constant head) and transitory (pulse test).

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II. MATERIALS USED FOR STUDY

In most cases the maximum allowable hydraulic conductivity for a barrier material is specified by the regulations. The base material, sand is usually a local material and can be different from regions to regions. The task to produce a barrier material in place, which meets the given criteria at adequate cost, requires good knowledge of the different factors affecting the final hydraulic conductivity of the mixture.

A. Bentonite of Maghnia

The term 'Bentonite' is now well established, and used to describe a clay material whose major mineralogical components belong to Smectite groups. Hence, bentonite is a very expansive soil. The most important bentonite mines in Algeria are situated in the western regions. The bentonite used in this study is extracted from Maghnia mine (Hammam Boughrara, 600 km west of the capital Algiers).

X-ray diffraction is one of the most widely used methods for clay minerals identification and studying their crystal structure within the soils. Diffraction test carried out on bentonite, showed that the predominant clay minerals are smectic types Figure 1, beside it reveals also the presence of illite, quartz, and traces of kaolinite.

The grain size distribution of the bentonite is shown in Figure 2. It is very fine clay; more than 60% of particles have a diameter less than 2 µm. It's Plasticity Indexes (LL = 141 % , PI = 93%); indicate that the bentonite of Maghnia is highly plastic clay, this is also confirmed by a large specific surface (Ss = 462 m^2/g). According to the Skempton classification [29], based on the activity (equation 1), the bentonite of Maghnia presents a high percentage of calcite Montmorillonite (Ca^{+2}).

$$A = \frac{PI}{C_2} \quad \text{..(1)}$$

A: activity

C_2: percentage of particles with a diameter less than 2 µm

B. Dune sand

Dune sand known as desert sand is a material largely available within the Algerian south. In this study the dune sand used is a local material from Laghouat region. According to the chemical analysis (Table 1), the major component of dune sand (around 95%), is the silicate groups SiO_2

The grain size distribution of dune sand is shown in Figure 2. Values corresponding to uniformity and curvature coefficients are C_u = 1.67 and C_c=1.1, respectively. Thus, according to the Unified Soil Classification System (USCS), the dune sand is classified as poorly graded fine sand.

C. Properties Of Dune Sand - Bentonite Mixtures

In order to get the required soil combination several dune sand – bentonite mixtures have been considered in this study : 3% B + 97% S, 5% B + 95% S, 10% B + 90% S, 12% B + 88% S, 15% B + 85% S (B: Bentonite, S: dune sand).

D. Consistence Limits

In soil mechanics, the fine materials are classified on the basis of consistency limits which can provide information on macroscopic behaviour [21] Atterberg limits obtained for different mixtures are presented in figure (3). The consistency limits are proportional with percentage of bentonite additions. Mixtures with less than 10% of the bentonite are non plastic soils. For percentage of bentonite additions between 10% and 12%, the soil shows a low plasticity, while with percentage of 15% the soil appears to have a moderate plasticity around 12.5 % (table 2).

E. Swelling behaviour

Swelling tests are carried out using a classical œdometer, according to the free swelling method [28]. The dune sand – bentonite mixture samples were prepared by a static compaction (velocity of 1 mm/min) for water contents and dry densities corresponding to the optimum Proctor conditions. Evolution of free swelling rates (G %) over time are shown in figure 4. The free swell rate of the bentonite is approximately 47.5%, while for S/B mixtures vary between 0.85% and 8.70%. As expected the free swell is proportional with bentonite additions.

For swelling pressure test the constant volume method is adopted [28] . Results of swell pressure (Pg), of S/B mixtures are indicated in table 3. When bentonite content addition is more than 10%, swelling pressure becomes greater than 100 kPa.

III. MEASUREMENT OF PERMEABILITY

A compacted layer of sand - bentonite mixture is often used as an insulation barrier [13, 14, 4, 18]. This two types of soils are clearly dissimilar in their properties such grain size, permeability, chemical activity, and strength, however when they are combined in an adequate ratio,_can yield an excellent materiel for insulation barrier to leachate due to its impervious characteristics.

The aim of this study is to highlight the effects of confining stress and the hydraulic gradient on the permeability coefficient with strain_containment. Three measurement techniques have been used to carry out this study : oedometer test, constant hydraulic head test "steady state", and measurement with pulse test " transition state ".

A. Permeability using odometer test

Indirect methods for evaluating saturated permeability k are based on results of odometer test [22, 24]. In this method the coefficients of volume change m_v [m^2/kN] and consolidation C_v [m^2/s] deduced from compressibility (Figure 5) and consolidation curves respectively, are used to obtain the permeability.

$$k = C_v \times m_v \times \gamma_w \quad \text{....................(2)}$$

The C_v coefficient is evaluated by Taylor's approach

A specimen of 50 mm in diameter and 20 mm in height is placed in metal ring and saturated during 24 hours. The loading pressure is selected according to a geometric progression σi+1 /σi =2. Evolution of saturated permeability of S/B mixture as function of loading pressures is shown in Figure 6

According to the results obtained it can be noted that:

For all soils, the permeability varies inversely with the loading pressures. For examples, when the loading pressure varies from 25 to 800 kPa, the permeability for mixtures, with higher bentonite additions, decreases approximately two orders of magnitude.

- The saturated permeability for dune sand varies between 1.1 10-5 to 1.9 10-6 m/s; whereas for mixtures with 15 % bentonite addition the values range from 7.41 10-9 to 4. 58 10-11 m/s;
- The effect of applied loading pressures on permeability is less significant, once the vertical pressure becomes more than 200 kPa. Other researchers found these limiting values around 100 kPa, [31] and 200 kPa [1].
- Permeability of the dune sand-bentonite mixtures decreases with increasing bentonite content. For high bentonite content more than 12%, the saturated permeability is less than 10-8 m/s.
- The target values relative to saturated permeability for contaminant liners, which should lay between 10-8 and 10-10 m/s, can be achieved for percentages of bentonite content greater than 12%, under an applied vertical pressure over than 100 kPa. While for percentage of bentonite addition around 15%, this target values is obtained under a low vertical pressure (around 25 kPa).

According to these results the adequate sand bentonite mixture which will be used for the following studies is 85% S + 15 % B.

B. Measure of permeability using triaxial cell

This section presents the effect of confining stresses and hydraulic gradients on the permeability of compacted mixture (85%S+ 15%B). The measurement of the saturated permeability is carried out with two different modes. The first is the permanent mode (constant head) and the second is the transitory mode (pulse method).

1. Materials and specimens

The saturated permeability is measured using a Perméamétre with flexible walls. The experimental set up is composed of a triaxial cell (Bishop-Wesley revolution) equipped with three pressure-volume controllers “GDS” (figure 7), The set up allows testing specimens of 35 or 50 mm in diameter and variable height to diameter ratio H/D. The triaxial cell permits to apply an isotropic confining stress (up to 1700 kPa). The flow is directed vertically from the bottom towards the top.

Specimens are prepared by static compaction with double piston at optimum normal Proctor conditions (wopt = 15.2 %, γd max = 17 kN/m3). Specimen dimensions are D= 35 mm and H = 70 mm. The displacement speed of the press is about 1.14mm/s. The static compaction was retained because it permits to obtain more homogeneous specimen [11].

2. Phase of saturation

Once the specimen is placed inside the triaxial cell, a confining stress of 100 kPa is applied in the first time. In order to extrude the existing air bubbles between the membrane and the soil a low back pressure is applied at the base of the specimen (ue: back pressure at the base at the sample, ue = 20 kPa, us: the pore pressure at the top at the sample, us = 0 kPa). The progressive increase of the confining stress and the backpressure allows to free air bubbles from the connecting tubes (ue = 30, ue = 40 kPa) meanwhile preserving an average constant effective stress. The final confining stress applied on the sample during the saturation phase must be greater or equal to the swelling pressure of the mixture, which is around 180 kPa.

3. Measurement of permeability in permanent mode (constant head)

The experimental program is carried out using two series-tests. The first one consists to investigate the effect of the average confining effective stress with a constant hydraulic gradient (□u = constant), whereas the second consists to analyse the effect the hydraulic gradient with a constant average confining effective stress (σ_3' = constant) (table 3).

With:

$$\sigma_3' = \frac{(\sigma_3 - ue) + (\sigma_3 - us)}{2} \quad \text{.....................................(3)}$$

The saturated permeability of soils is based on the Darcy law; which describes the relation between water quantity, which flows through a cross section during an elapsed time, and hydraulic gradient. It is expressed by the following equation:

$$v = \frac{Q}{A} = -ki \quad \text{..(4)}$$

v : Darcy flux [m/s] ;
Q : volumetric flow rate [m^3/s] ;
A : flow area [m^2]
k : permeability [m/s]
i : hydraulic gradient :

$$i = \frac{\Delta u}{\gamma_w H} \quad \text{..(5)}$$

γ_w: unit weight of water[kN/m^3]
Δu : pressure gradient variation (u_e- u_s) [kPa]
H : height of specimen [m]

4. *Measurement of permeability in transitory mode (method of pulsates)*

Principle of the method

Because of the short duration of the test compared with the other techniques, this method is very useful to obtain a first estimation of the coefficient of permeability [2, 7]. The principle of the impulse shock test also called "pulse test" consists to subject a soil specimen to an instantaneous differential pressures applied on both ends (Δu_0 = ue-us). In the case of saturated specimen, the coefficient of permeability k can be computed constantly using Darcy law, considering the flow is running out under the average hydraulic head during the pressure dissipation within an elapsed time.

The permeability is obtained using the first part of the dissipation curve (start of the drop) which corresponds to the time interval between 500 to1000 s. The coefficient of permeability is given by the following equation:

$$k = \frac{\Delta Vw.H}{\Delta t.S(\frac{ue-us}{\gamma w}+H)}......................................(6)$$

ΔV_W: volume of infiltrated water [m^3];
S: cross section of specimen [m²];
Δt: time interval [s]
H: height of specimen [m];

As in the permanent mode, the experimental program of the transitory mode (Table 4) is carried out on two series of tests. The first consists to investigate the effect of the average confining effective stress and the second consists to analyse the effect of the pressure gradient variation Δu on the permeability coefficient (table 4).

C. *Experimental Results and discussions*

1) *Permanent mode (constant head)*

- *Average confining effective stress effect*

Figure 8 show the variations of void ratio and the coefficient of permeability as a function of the average confining effective stress, respectively. It can be noted that the effect of the average confining effective stress on the permeability is more significant for value less than 200 kPa, beyond this stress the permeability seems to be almost constant, which in agreement with oedometer results. The measurement of the change in the volume of water throughout the test, allow to deduce the final volume of voids. From the same figure, it can be seen that the void ratio decreases when the average confining effective stress increases and consequently result in a reduction of permeability.

- *Average Hydraulic gradient effect*

In the second case of the measurement of the saturated permeability, the average confining effective stress is kipped constant (σ_3' = 400 kPa) while varying the hydraulic gradient.

Figure 9 presents the evolution of velocity of water through the specimen as a function of the hydraulic gradient. The experimental results can be approximated by the following linear relation.

$$v = 6.72\times10^{-10}.i...(7)$$

Such linear relationships agree with the Darcy law in the range of hydraulic gradient considered. Similar results have been obtained by other authors [17, 7]. From figure 10 it can be noted that there is minor effect of the hydraulic gradient on the permeability results.

.2) *Transitory mode (method of pulsates)*

- *Average Confining stress effect (constant hydraulic gradient)*

Figure 11 shows the pressure dissipation versus time for each average confining effective stress applied (400-1300 kPa). The time of pressure stabilization (ue = us) where the permeability can be estimated, is situated between 30 and 50 min.

Figure 12 presents the permeability variation versus average confining effective stress for Δu_0 = 50 kPa. It can be seen that the permeability which is about $2x10^{-09}$ m/s seems to be constant with applied average confining effective stresses (σ_3' ≥ 400 kPa). Which are in accord with results obtained by permanent mode.

- *Average effect of initial pressure variation Δu_0 (pulse test)*

Figure 13 shows the pressure dissipation versus time for each variation of initial pressure (Δu_0) under an average confining effective stress around 400 kPa. It is noted that the time of stabilization of pressure (ue = us) where the permeability can be estimated in less than one hour.

Figure 14 presents the permeability variation as a function of initial pressure variation. This coefficient is slightly affected by the value of applied initial pressure. The approximated value is equal to $6x10^{-9}$ m/s.

The pulse test allows us to get a good estimate of permeability for clayey soil, within an hour compared to the permanent mode which can last for several days.

In figure 15 the results of permeability tests using triaxial cell with two modes (permanent mode and transitory mode), are grouped. First we can note that the permeability values obtained in permanent mode are lower than those given by transitory mode. The difference between the two results is around one order of magnitude. The effect of confining effective stress is more clearly for permanent regime.

IV. CONCLUSION

In this research study we have shown that it is possible to obtain an adequate mixture intended for insulation barriers, using dune sand and a small amount of bentonite addition. According to the results obtained from this experimental study, we can advance the following conclusions

The common requirement on hydraulic conductivity (should be less than (10-8 -10-10) m/s) is met for compacted soil with a minimum of 12% of bentonite addition;
The relationship between the hydraulic conductivity and the swell of S/B mixture is well illustrated. As expected these two properties are inversely proportional;
The results of the permeability obtained by the oedometric tests are lower than those obtained by the triaxial cell, this can be attributed to the lack of saturation of the specimen under oedometric conditions and some air bulbs may remain trapped within the soil;
Because of the short times of the pulse test compared with the other processes, this test is very useful to obtain an initial estimate of the permeability coefficient;
The permeability decreases with increase of confining stress which due to the reduction of void ratio,The results of permeability using two modes (permanent mode and transitory mode) under confining stress conditions are almost similar the difference is around one order;
According to the results of permeability obtained by different methods, the adequate mixture proposed for the design of the worked barriers in the arid region (southern of Algeria) is 85% S + 15% B. In addition such mixture presents a moderate swelling and shrinkage potentials and hence it will be less subjected to cracks under drying conditions;
Finally, it can be stated that the use of dune sand, which is a local largely available material in the south of Algeria, with small quantities of bentonite additions can provide an economical insulation barrier for waste disposal management.
The procedure on site for mixing and placing of sand-bentonite mixture along with strict control of compaction procedures play an extremely important role for the final quality of the barrier [14].

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Figures

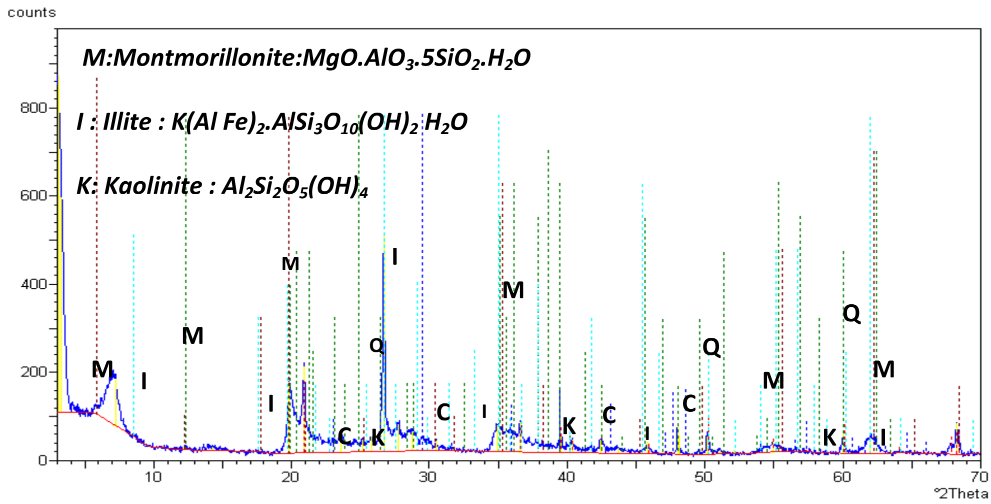

Fig. 1. X-ray diffraction analysis of bentonite of Maghnia

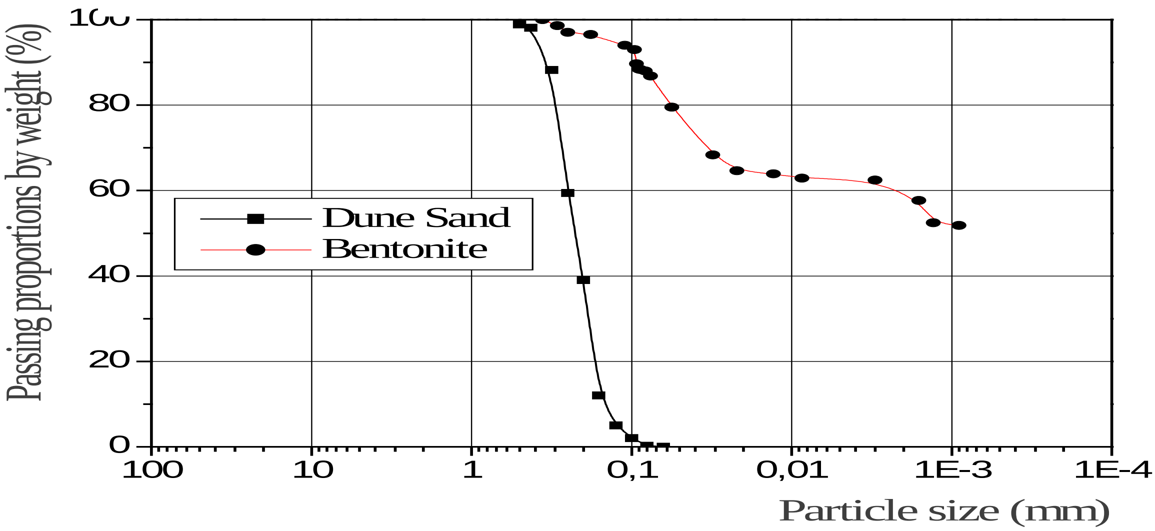

Fig. 2. Grain size distribution of bentonite and dune sand

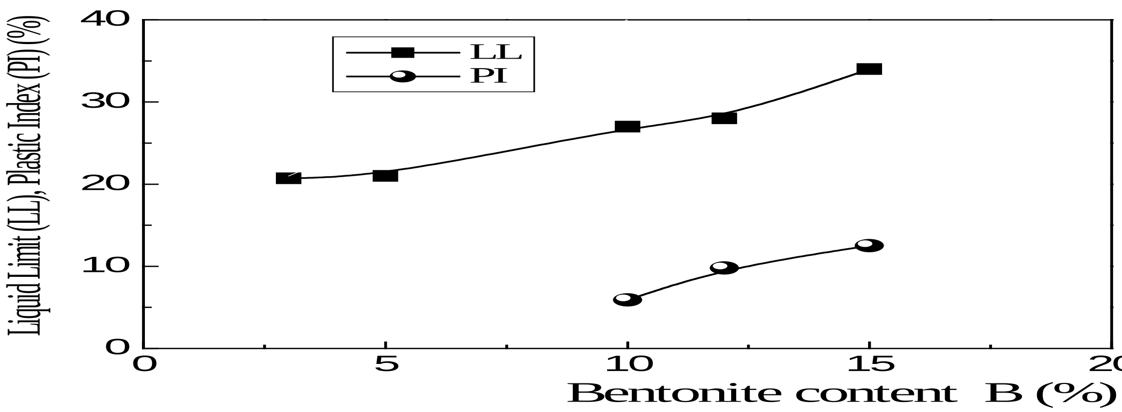

Fig.3. Relationship between Atterberg Limits and Bentonite content

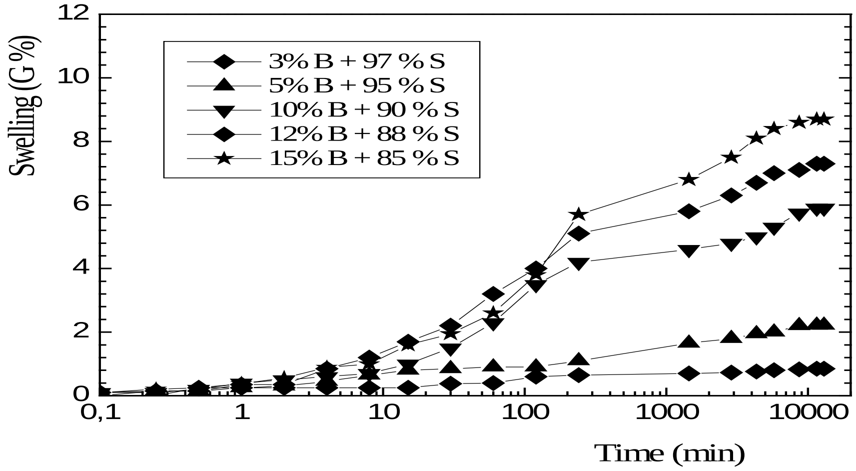

Fig. 4. Swelling evolution of S/B mixtures versus time

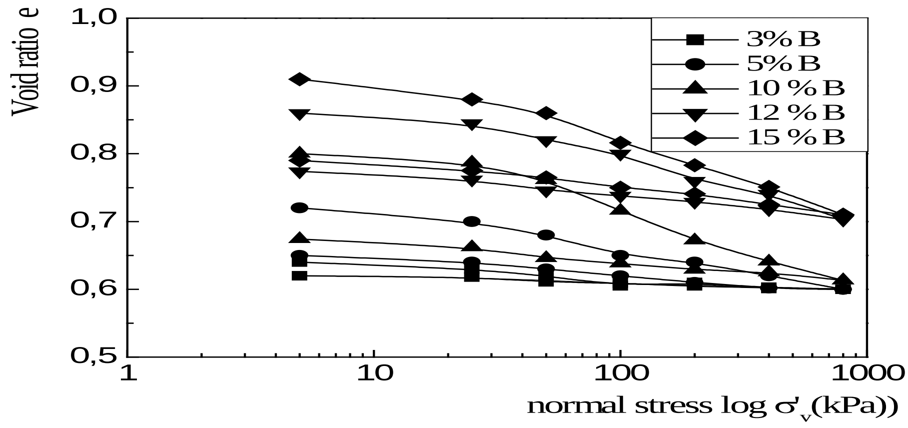

Fig. 5. Compressibility curves of mixtures s/b

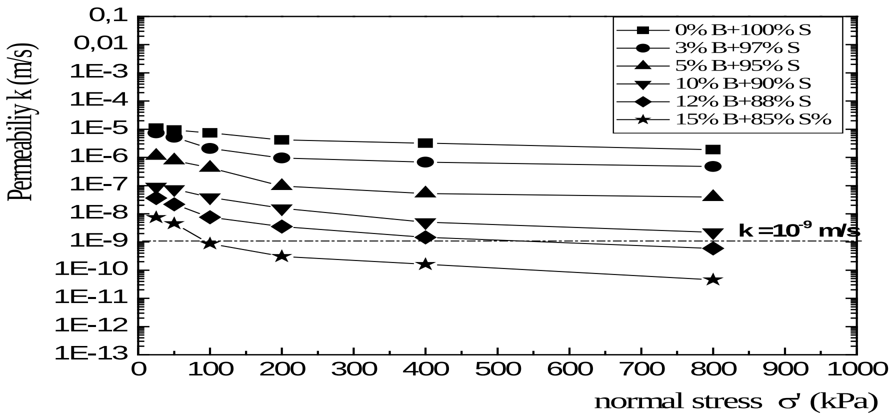

Fig. 6. Permeability coefficient of s/b mixtures vs normal stress

Fig. 7. Triaxial cell of type Bishop-Wesley revolution controlled with three pressure-volume controllers

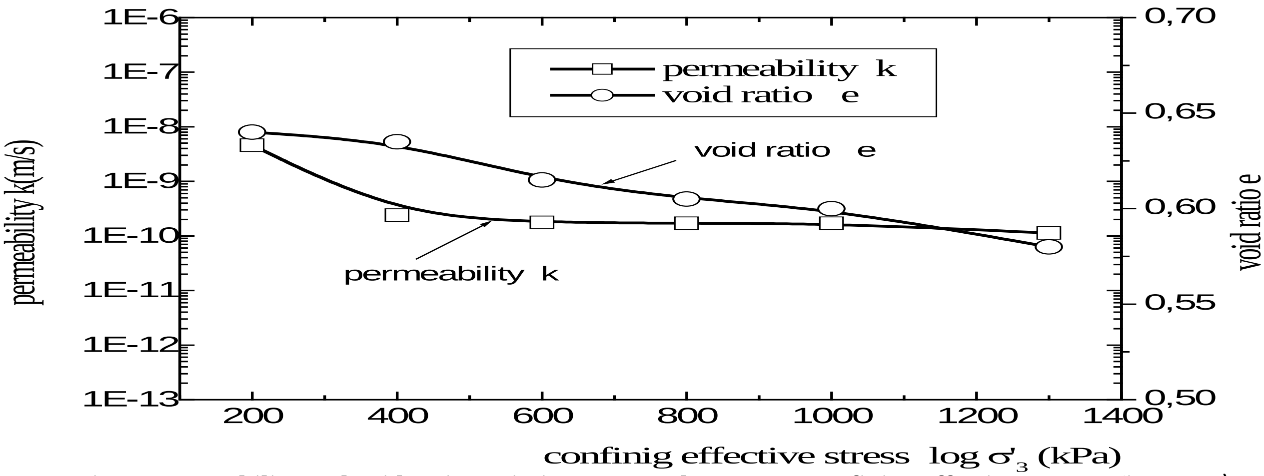

Fig. 8. Permeability and void ratio variations versus the average confining effective stresses (i = 57.14)

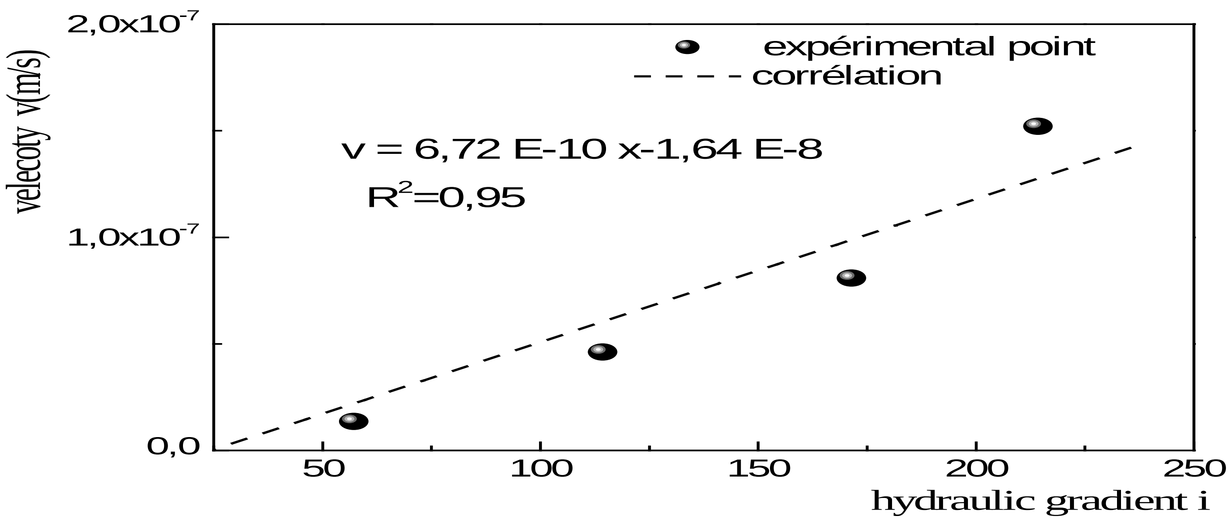

Fig. 9. Velcoty evolution of flow through specimen as a function of the hydraulic gradient,

(σ_3'= 400 kPa)

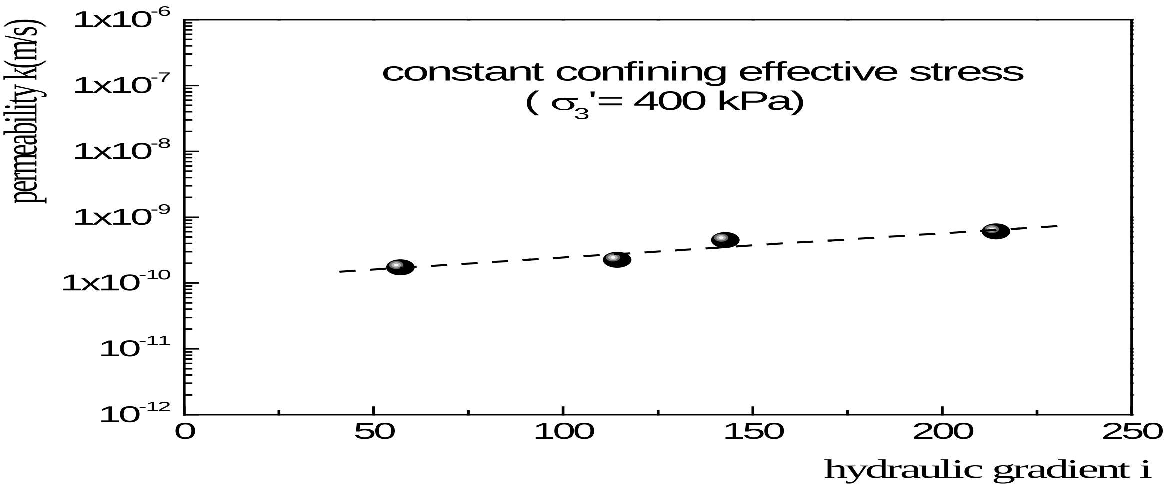

Fig. 10. The permeability results as a function of the hydraulic gradient (σ_3'= 400 kPa)

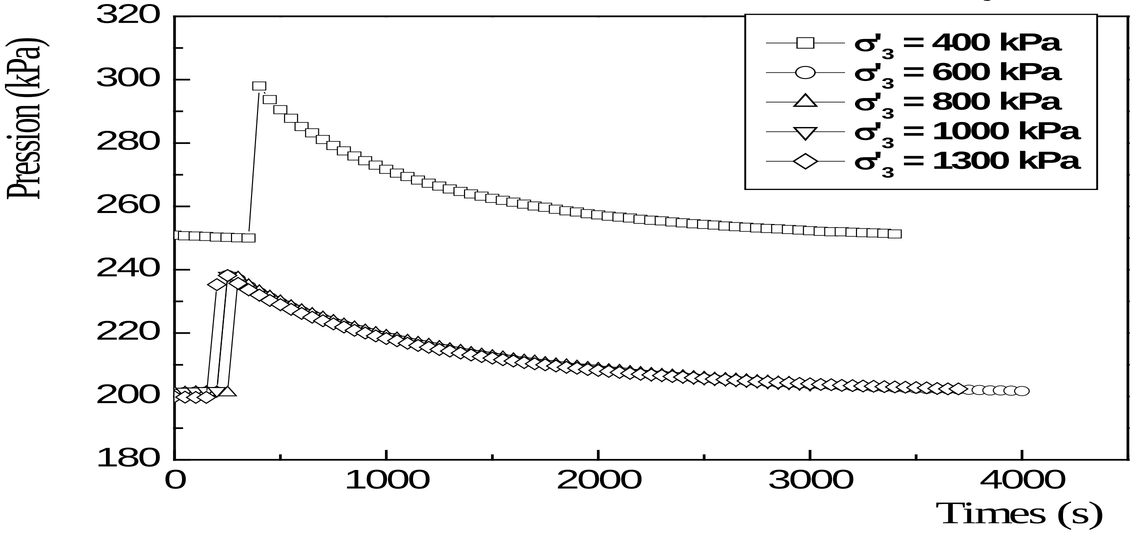

Fig. 11. Pressure dissipation versus time for each average confining effective stress

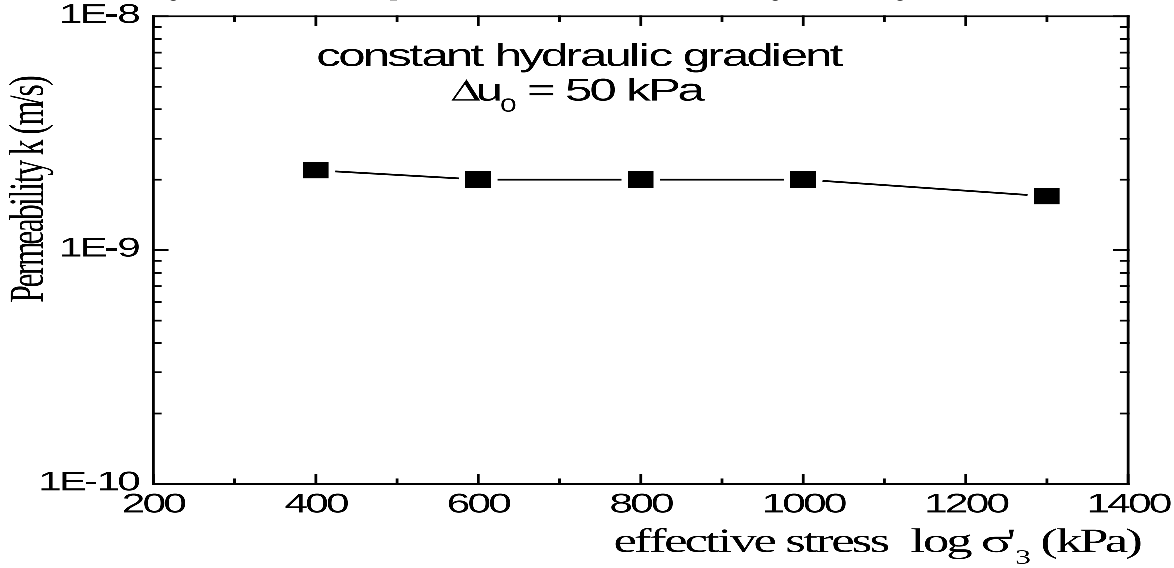

Fig. 12. Permeability variation versus average confining effective stress (Δu_0 = 50 kPa)

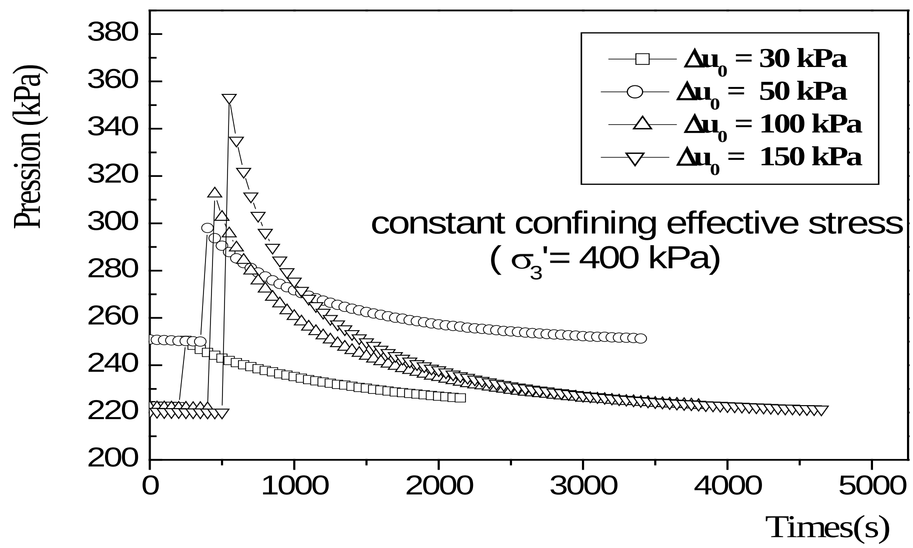

Fig. 13. Pressure dissipation versus time for each variation of initial pressure (Δu_0), σ_3' = 400 kPa

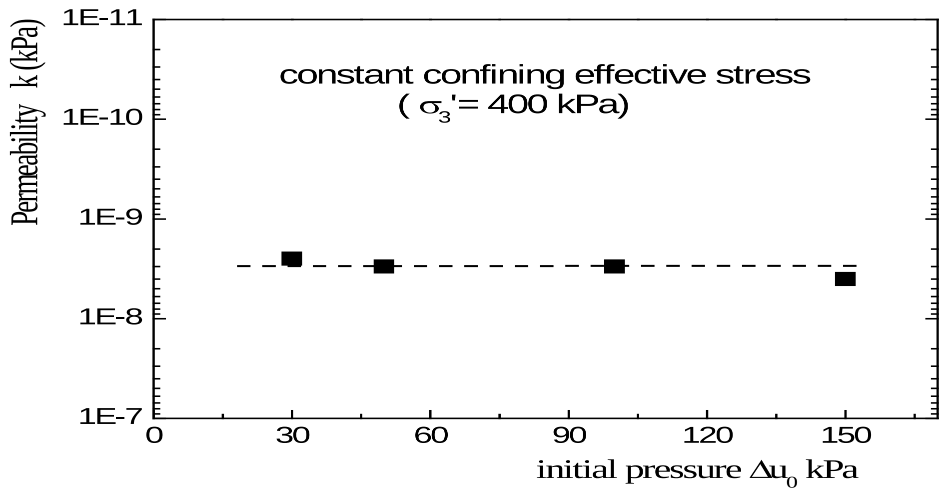

Fig. 14. The permeability variation as a function of initial pressure variation (σ_3'= 400 kPa)

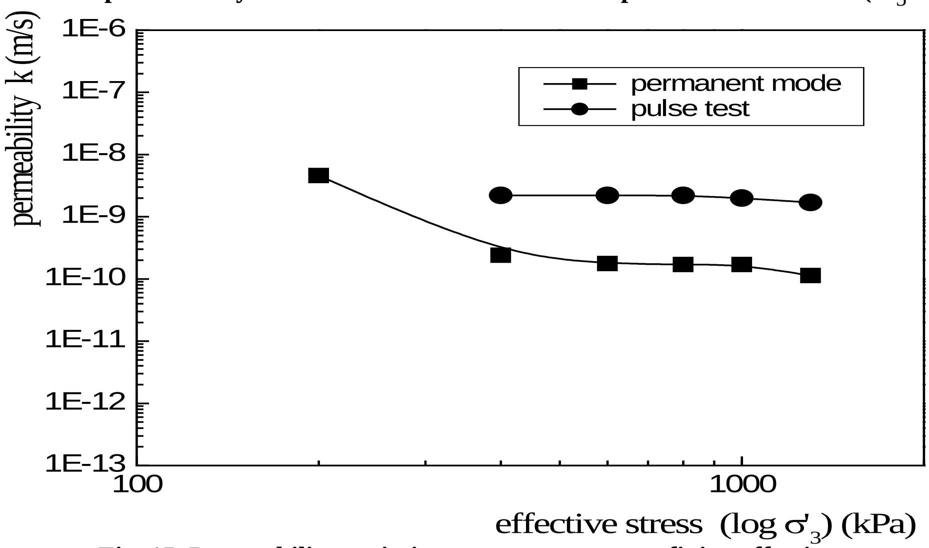

Fig. 15. Permeability variation versus average confining effective stress

Table 1. Chemical composition of the dune sand

SiO_2 %	SO_3%	Cl %	$CaCO_3$%	M.O %
95.,87	0.91	0.36	2.5	------

Table 2. Physical and mechanical properties of S/B mixtures

%S	%B	γ_d (kN/m^3)	w_{opt} (%)	LL %	PL %	PI %	G %	Pg (kPa)
100	0	19.2	10	---	---	---	---	---
97	3	19.1	10.5	20	---	---	0.85	17
95	5	18.8	11.5	21	---	---	2.22	38
90	10	18.3	12.8	27	21	6	5.90	124
88	12	17.8	14.0	28	18	10	7.30	150
85	15	17	15.2	34	21.5	12.5	8.70	178
0	100	12.1	32.0	141	48	93	47.5	852

Table 3. Loading sequences for permeability measurement in permanent mode

	σ_3 (kPa)	ue (kPa)	us (kPa)	Δu (kPa) (ue-us)	i	σ_3' (kPa)
constant hydraulic Gradient	200	40	0	40	57.14	180
	420	240	200	40	57.14	200
	620	240	200	40	57.14	400
	820	240	200	40	57.14	600
	1020	240	200	40	57.14	800
	1220	240	200	40	57.14	1000
	1520	240	200	40	57.14	1300
constant effective stress	620	240	200	40	57.14	400
	640	280	200	80	114.28	400
	660	320	200	120	171.42	400
	675	350	200	150	214.28	400

Table 4. Loading sequences for permeability measurement in transitory mode (Method of pulse test)

	σ_3 (kPa)	ue(kPa)	us(kPa)	Δu_0(kPa)	σ_3'(kPa)
initial pressure variation (Δu_0) constante	600	200	200	50	400
	800	200	200	50	600
	1000	200	200	50	800
	1200	200	200	50	1000
	1500	200	200	50	1300
constant effectif stress	600	200	200	30	400
	600	200	200	50	400
	600	200	200	100	400
	600	200	200	150	400

Arresting Project Slippage -A Case Study on an Indian Infrastructure Development Project

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GJRE Classification (FOR)
090502, 090505, 040403 & 090506

Abstract: **The paper presents a case study on infrastructure development work for Whirlpool Refrigerator Plant implemented near Pune, Maharashtra, India during the year 1997-1998. The project was taken up by Whirlpool of India (WOI) on a crash basis with consulting engineers Gherzi Eastern Limited (GEL) of Mumbai, India as the management consultant and was completed in a record time of about one year from ground breaking. The model for arresting project slippage consisted of breaking the project down to manageable work packages developing logic network showing interrelation amongst activities, estimating activity duration by deterministic/probabilistic method, analyzing, optimizing the networks and issuing the same for follow up. Updating involved deciding the update interval, obtaining reliable feed back data in good time, analyzing, validating and issuing updated reports. The project response to the corrective action applied was kept under constant review and action revised where ever necessary till response was satisfactory. The project was completed within about one year from ground breaking which was slightly ahead of schedule. The experience of this project implementation has been very useful for other Indian projects executed subsequently.**

Keywords: Delay Analysis, Gantt Chart, Network, MS Project, Slippage.

I. Introduction

Whirlpool is white goods major in USA and a leading manufacturer of domestic appliances like washing machine, refrigerator, etc. Their products are marketed in more than 140 countries including India. Whirlpool of India (WOI) is the Indian subsidiary of Whirlpool of USA. WOI had set up a Refrigerator Manufacturing Plant at Ranjangaon, 55 km from Pune on the Pune-Ahmednagar Highway in the State of Maharashtra, India. The plant was planned to produce in Phase I Refrigerators (No Frost and free from Chloro Fluoro Carbon] Free) up to 7,00,000 units per year. Production of refrigerators actually commenced in late 1997. Keeping in view the Montreal Protocol banning, the use of CFC from ecological considerations WOI decided to take up manufacture of CFC free, no-frost refrigerators in India for domestic consumption and export.

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As Construction Manager of Gherzi Eastern Limited (GEL), the management consultant on the project implementation, the first author was in-charge of overall project coordination and control of construction.

Water, utilities, power and other services for the project included the following:

- Roads and Pavement.
- Storm Water Drainage.
- Yard Facilities.
- Chilled Water, LPG/Propane, HSD Systems.
- Cooling Water System.
- Compressed Air System.
- HT and LT Installation.
- Standby Power System.
- Ventilation System.
- Evaporative Cooling System.
- Air-conditioning System.
- Fire Protection System.
- Raw/ Treated Water Storage and Circulation.

The major infrastructure and services involved:

Treated water storage capacity……………………….570 m3
Raw water including fire water storage capacity …3,180 m3
Storm Water Drainage lines……….. 4,220 running metre
Roads and Pavement area……………………… 20,700 m2

Water and power for this project were drawn from the Maharashtra Industrial Development Corporation (MIDC) and the Maharashtra State Electricity Board (MSEB) respectively. However, for the construction work, all the contractors had to make their own arrangement for procuring water in tankers from local sources and power by installing their own diesel generator sets. Other technical details are reported in Kar (1998).

To get an overall idea of the project in general, the following photographic views are given : Fig. 1 gives a view of civil work for pump house and cooling tower. The overhead piping, pump house and cooling towers is presented in Fig.2. Similarly, Fig.3 shows an overall view of the effluent treatment plant.

Fig. 1. A photographic view of the civil work for pump house and cooling tower

Fig. 2. Overhead piping, pump house and water tanks.

Fig. 3. Effluent treatment plant.

II. MODEL FOR ARRESTING PROJECT SLIPPAGE

The model for arresting project slippage has been reported in details elsewhere [Kar (2007) and Kar *et al.* (2008)]. It consisted of breaking the project down to manageable work packages and detailed activities, introducing activity interrelationship, developing logic network, estimating activity duration by deterministic and/or probabilistic method, analyzing the network, evaluating and balancing/optimizing it, and issuing the stabilized network for follow up. Updating consisted of deciding the update interval, obtaining reliable feed back data in good time, analyzing, validating and issuing the updated reporting the desired format. Slippage control consisted of delay identification, delay quantification, delay analysis, problem analysis, and corrective action. The project response to the applied corrective action was measured. In case of unsatisfactory project response the corrective action was revised till satisfactory response was received. The model also included streamlined procedures for Procurement, Quality Assurance and Quality control (QA/QC), Health, Safety and Environment (HSE), Human Aspects and Public awareness, Communication and Information Technology, etc. The details of the model has been published elsewhere (Kar *et al.*, 2008).

III. EFFECTIVE TIME MANAGEMENT

For effective time management, the methodology suggested by Gioia (1996) and Paula & Tate (2001) are followed as preliminary guidelines. Initial planning was done through detailed Work Breakdown Structure (WBS). Close monitoring and follow-up was done through computerized activity networks using MS Project software. The detailed planning was based on Project Breakdown Structure (PBS) developed initially forming the basis for further detailed planning. Actual accomplishments were constantly compared with the plan and prompt corrective actions decided and effectively applied.

The work program used during project execution was a network based Gantt chart. The work was followed up regularly during the execution of the project was done with substantial success aiming at arresting slippage. A project log book having diary of events was maintained at the work-site where all major events were logged on daily basis. This helped substantially in controlling delay. Fig. 4 presents a typical format for punch list for construction work showing the items of work remaining to be completed. The list helped in closing the construction work in stages. Fig. 5 shows a format for controlling handing over schedule for civil and structural work. A typical format for handing over / taking over protocol for various units is presented in Fig.6.

Sheet of
Date :

NAME OF WORK :
NAME OF CONTRACTOR :
WORK ORDER NO.:

WOI-GNF Project, Ranjangaon, Pune, India
PUNCH LIST FOR CONSTRUCTION WORK

Sr. No.	Bldg/ Facility/ Unit with item of work and location	Details of works to be completed/ rectified/ replaced	Inspected and Signed by		Proposed Compliance Date	Inspection for Final - Compliance		
			Contractor	GHERZI		Signed		Date
						Contractor	GEL	

Fig. 4. Format for punch list for construction showing items of work to be completed with targeted completion.

WOI GNF PROJECT, RANJANGAON, Pune, India
CIVIL/STRUCTURAL WORK HANDING OVER SCHEDULE

Sheet of

Sl. No.	*Building/ Facility/ Unit*	*Contractor*	Preparation and issue of punch list	Date by which punch list to be attended to	Date of Handing over Unit to WOI	*Remarks*

Date

Fig.5. Format for handing over schedule for civil and structural works.

WOI-GNF PROJECT, RANJANGAON, Pune
HANDING OVER-TAKING OVER PROTOCOL

REF. NO. WOI/1125/ / / Sheet of
NAME OF WORK : Date :
NAME OF CONTRACTOR:
WORK ORDER NO:
BLDG / FACILITY / UNIT HANDED OVER TO WOI:
EFFECTIVE DATE OF HANDING OVER:
PUNCH LIST REFERENCE & DETAIL:

OBSERVATIONS:

CONTRACTOR	WOI	GEL

REMARKS

CONTRACTOR	WOI	GEL

HANDED BY **TAKEN OVER BY** **WITNESSED BY**

__________ _______________ ____________

CONTRACTOR **WOI** **GEL**

Fig. 6. Format for Handing Over-Taking Over Protocol.

The list of miscellaneous works / man power supply was to record unscheduled assignment which had to be settled on daily wage basis. This helped in settling claims and thus keeping control on the project. Handing over and taking over protocol was followed in a proper systematic manner for various project components amongst the three main parties, viz. Owner, Contractor and Consultant. This was essential for keeping a proper official record of final closing down of each contract. These particular formats, unlike standard formats as prescribed in normal public sector projects, were specifically developed by the author for better and authentic record keeping and follow up action.

Each delay was analyzed to locate the root cause and ascertain the possible remedial measures keeping in view the likely financial implications. Most delays were put on record on a regular basis. The major reasons for delay were evaluated and could be summarized as per Table-1. However, occurrence of such delay, did not affect the overall project schedule. Table-2 depicts the manpower deployed by contractors at the peak period of construction. The equipments deployed by a contractor during the peak period, on the other hand, have been presented in Table-3.

Table-1: Delay Analysis

Sl. No.	Reasons of Delay	Amount of Delay (Days)
1	Un-seasonal heavy rainfall of high intensity	30
2	Water supply stoppage by MIDC	2
3	Power cut by MSEB	3
4	Local Festivals	10
5	Local strike & unrest	10
6	Closures due to workers' agitation	5
7	Other reasons	5
	Total delay :	65

Table-2: Manpower deployed by various contractors at peak period.

Sl. No.	Category	Average Nos. Deployed
	Structural Steel Work by PETRON	
1	Supervisor	8
2	Fitter	27
3	Welder	35
4	Gas Cutter	11
5	Tack Welder	20
6	Rigger & Khalasi	112
7	Helper	95
8	Marker	14
9	Driller	11
10	Grinder	10
11	Painter Gang (incl Buffer + Supervisors)	72
	TOTAL	415
	General Civil Works by PETRON	
1	Carpenter	72
2	Fitter	42
3	Helper	170
4	Mason	68
5	Unskilled Labour	501
6	Bhisti	12
7	Waterproofing	25
8	TOTAL	890
	Fire protection system by KIRLOSKAR Consultants	
	Supervisor	
1	Welder	2
2	Fitter	11
3	Gas Cutter	7
4	Rigger & Khalasi	4
5	Helper	27
6	Grinder	17
7	Painter	2
8	TOTAL	8
	Low Tension Works by Bombay Suburban Electric Supply	78
1	Electrician	
2	Fitter	18
3	Welder	6
4	Unskilled	15
		39
	Total :	78

Table-3: A typical sample of equipments deployed by a contractor at peak period

Sl. No.	Equipment	Total Nos. Deployed at Site
	PETRON	
1	Welding Transformer	34
2	Rectifier	4
3	Pug Cutting Machine	8
4	Radial Drill M/C (upto 32 mm diameter)	1
5	Pillar Drill M/C (upto 50 mm diameter)	1
6	Magnetic Drill M/C (upto 27 mm diameter)	13
7	Pistol drill M/C (upto 37 mm diameter)	2
8	Hydra Cranes (5 Metric Ton and 8 Metric Ton capacity)	2
9		1
	Crane (20 Metric Ton capacity)	
10		2
	Diesel Generator Set (125 KVA)	
		1
	Diesel Generator Set (160 KVA)	
		1
	Diesel Generator Set (200 KVA)	
11		13
	Grinding Machine (AG7)	
		10
	Grinding Machine (GQ4)	
		1
	Grinding Machine (FF2)	
12		2
	Jem Screw (5MT)	
		1
	Jem Screw (3MT)	
13		1
	Chain Pulley Block (5 Metric Ton)	
		5
	Chain Pulley Block (3 Metric Ton)	
		3
	Chain Pulley Block (2 Metric Ton)	
		1
	Chain Pulley Block (1 Metric Ton)	
14		5
	Crab Winch (5 Metric Ton capacity)	
15		6
	Pullar (Metric Ton capacity)	
		2
	Pullar (3 Metric Ton capacity)	
		1
	Pullar (8 Metric Ton capacity)	
		1
	Pullar (2.5 Metric Ton capacity)	
17		1
	Shearing Machine	

Effective construction monitoring was done through progress meetings, review meetings, meetings on quality control, construction safety. Strict measures were applied against pollution and health hazards. All workers were provided with essential safety implements like helmet, safety shoes, gloves, safety harness, goggles etc. Workers without these essential safety implements were refused permission to enter the project site. Regarding the environment at site every effort was made to keep the site clean and tidy. All low areas were kept well drained to prevent breeding of mosquito and harmful organisms. Adequate workers toilets were provided at site. Those creating nuisance at site were thrown out and suspended for a few days. Female workers were not allowed to work at site after dusk in compliance with local rule in force.

The key to project success was attributable to a totally dedicated team, total involvement and commitment of all concerned, excellent top management support, quick decision by WOI on all day to day problems and their implementation, focusing utmost attention on the end objective and, good coordination and communication.

Water and all other services were made available in time enabling trial production to start in about one year of ground breaking. The project was completed on schedule within the approved budget.

Procurement was done through limited tenders issued to pre-qualified bidders followed by close price negotiation. WOI philosophy was to give the job to the technically most competent party provided they were competitive price wise. This was the US culture which was modified marginally to suit Indian conditions. The approach worked well on this project.

Quality assurance and quality control (QA/QC) and heath, safety and environment (HSE) were closely monitored and followed up. Both QA/QC and HSE were continuous efforts exercised on this project on a sustained basis. Apart from frequent detailed site inspection, tests were conducted at site as well as in recognized laboratories in Pune and Mumbai.
Quality system improvement was carried out broadly as follows:

- Maintaining quality standard and improving work efficiency
- Innovating by setting up new quality standards and strategies
- Management Review-
    - To check the effectiveness the system operation was constantly reviewed.
    - Opportunities for quality improvement were regularly investigated.
    - Complaints from owner were kept under constant review.

- Corrective action-
  - Defects were analyzed with identification of the root cause.
  - Corrective action was devised and monitored.
  - Adequate steps were taken to avoid major non-conformities.
- Preventive Action-
  - Where non-conformities were likely to occur in the existing system adequate preventive actions were taken.

In general the following measures were taken to ensure good QA/QC standards-

- Using standardized methods for verification of quality.
- Reducing complexity of site operations.
- Strict adherence to established practices.
- Better compliance of statutory regulations at site.
- Better compliance of HSE standards at site.
- Better compliance of pollution control measures at site.
- Efforts to maintain a clean environment at site.
- Maintaining records as per established procedures.
- Evaluating performance at site.
- Improving and innovating work methods at site.

Participation at the working level was given top priority to achieve effective quality standard. Substantial quality accomplishment was achieved on this project due to a good team work and commitment of all concerned on quality aspects.

To achieve effective quality control and HSE priority was given to participation at the working level. A good team work and commitment to health, safety and environment by the entire team led to the implementation of this project with high accomplishment on HSE standards. It however, was rather difficult to achieve as both quality and safety culture in construction is yet to get firmly rooted in India.

Detailed instructions were issued to each contractor and these were strictly implemented during construction. A dedicated safety engineer was deployed at site and he was assisted by the plant security personnel in implementation of the Safety Standards. The HSE standards adopted were in conformity with the prevailing Rules and Acts of Law in force. The HSE efforts included essentially regular briefing to contractors' supervisory personnel and workers on Health and Safety Norms to be followed at site. These included the basic rules for use of equipment and tools such as mobile equipment, cranes, lifting tackles, manually operated equipment, pneumatic equipment and tools and electrical equipment. The safety practices for building construction included safety guidelines during execution of blasting, excavation in trenches and pits, scaffolding, structural erection, roof sheeting and cladding. Detailed instructions were given for use of electrical power at construction site in conformity with Indian Electricity Act. Personal protection and fire safety during welding and gas cutting were closely followed-up at site.

Personal protection equipment like safety shoes, helmet, safety belt, gloves, goggles were made compulsory. Safety instructions were also issued for prevention of vehicular accidents. All contractors had their own First-Aid kit at site. Trained medical assistants with medical kit were made available with necessary vehicle for evacuation of casualties to the nearest hospital or medical centre. Special attention was paid to protection against fire hazards. Barricades were erected and maintained wherever necessary to prevent possible accidents. The project has been completed with commendable safety accomplishments which is not common in Indian construction sites.

The project was monitored closely through regular review meetings at close intervals at site, at the Owner's office-WOI, Pune and at the office of Gherzi Eastern, the Consulting Engineers in Mumbai. The total project was completed in record time with the first refrigerator coming out of the plant within one year of ground breaking. This was a remarkable achievement in India where project slippage is a rule rather than an exception. The water, utilities and services however, were completed in good time to meet the production requirement.

IV. CONCLUSION

The WOI Refrigerator Plant in Pune, India was completed in about one year starting from ground breaking. This could rightly be claimed as a remarkable achievement under Indian conditions where normally projects tend to get delayed sometimes beyond control due to political, local, social and other unforcing circumstances.

Project success was achieved through the application of proven techniques like WBS, activity networking, common management software adopting a methodical approach, in-depth meticulous detailing and rigorous follow-up action. This was achieved through effective construction monitoring by way of regular progress meetings on QA/QC, HSE, etc. Strict measures were adopted against pollution at the site and the surrounding areas with consequent health hazards for the workers and the neighboring populations. To ensure workers' safety, all of them are provided with essential safety implements like hard hats, safety shoes, gloves, goggles, etc. Regarding procurement, WOI philosophy was to award the work to the technically most competent bidder having good past record provided they are competitive in price. This practice was adopted in this project as against the normal Indian practice of awarding the job to the cheapest bidder irrespective of their technical competence and past record. The quality assurance and quality control aspect in the project was closely monitored with all the contractors. Participation of ordinary workers was encouraged contributing towards HSE and compliance with the schedule.

The key success factor could be attributed to a totally dedicated team, total involvement and commitment of all concerned, excellent top management support, quick decision by WOI on all day to day problems and their prompt resolution. The lessons learnt on this project were found to be very useful for other Indian projects taken up subsequently and the construction industry in general in other developing countries.

V. ACKNOWLEDGMENT

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Factors Influencing the Productivity of Concrete Placing by Cranes in Nigeria

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GJRE Classification (FOR) 090502, 090506, 090507 & 090403

Abstract- **Productivity in the Nigerian construction industry has been branded as extremely low by a number the industry researchers and conspicuous project failures. The motivation for this research therefore derived from the need to establish benchmarks for site productivity in the country. Tower crane with skip is emerging as a dominant means of placing concrete on sites in Nigeria and against the backdrop of low productivity, this study attempts to benchmark the productivity of placing concrete by crane&skip against established productivity of similar operations in other developing countries most especially Hong Kong where extensive research had been carried out the subject. The study made use of 25 building construction sites in Lagos metropolis with 35 separate pours earmarked for observation. The result showed that for a mean pour size of 41.6 m3, the overall productivity was 11.24 m3 /hour. This productivity figure compared favourably with 12.2 m3 / hour for a pour size of 89 m3 and 11.3 m3 /hour for a pour size of 49 m3 obtained in two different studies in Hong Kong. The multiple regression analysis (MRA) on factors affecting the productivity of concrete placing by crane showed that type of pour, pour size, and fractional delay (the delay time expressed as a fraction of the pour duration) are the most significant factors. It was recommended that planning engineers should note these three variables in future planning of concrete placing by crane.**

Keywords- concreting, crane, productivity, Nigeria

I. Introduction

The quest for improved delivery of products and services, and the associated enhancement of human life have been the drivers for continuous productivity studies in almost all human endeavours. This is especially true in the manufacturing industry. The construction industry as a manufacturing concern in its own right has been in the forefront of productivity studies in various dimensions since the early 1970s. One of the cardinal areas of focus in the last two decades has been concreting. Concreting remains the most common operations on construction sites since the medieval period. According to Graham, Smith and Tommelein (2005), the construction industry is the largest consumer of concrete globally. The continued dominance of concreting activities on site has in recent years aroused the curiosity of construction industry researchers as to the efficiency and effectiveness with which concreting activities are carried out. Concreting operations include batching, transporting and placing and hence the operational productivity of equipment and labour is an essential and intrinsic parameter influencing output in the construction industry (Chan and Kumaraswamy, 1995; Wang, Ofori, and Teo, 2001; Dunlop and Smith, 2003). The Nigerian construction industry although branded as a low productivity industry (Fagbenle, Adeyemi and Adesanya, 2004), is fast transiting from labour intensive industry and heralding the use of tower crane and skip for concrete placing in medium and large construction sites. Like elsewhere in the world, cranes have become the equipment of choice for pouring concrete in the Nigerian construction industry. This phenomenon represents a gradual move away from the dominant use of head pan and wheelbarrows for transporting and placing concrete. In this paper, we examine the intrinsic factors that have influence on concrete placing by crane in the Nigerian construction industry in comparison with similar studies in other developing countries of the world, most especially in Hong Kong where intensive research output has been documented.

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II. Methodology

For the purpose of this study, all building construction sites involving the use of tower crane in Lagos metropolis were visited during a pilot study (Olaoluwa, 2008). Lagos metropolis was selected for the study because it is a typical mega-city with the largest concentration of construction sites manned by all categories of contractors. The pilot study revealed 25 project sites where separate concreting *operations using crane could be studied. Thirty five separate pours made up of 22 pours for beam and slabs, and 13 pours for columns and walls were earmarked for observation on these sites during the survey. In order to make meaningful comparison with concreting productivity by crane elsewhere in the developing countries, this investigation build on similar work conducted in Hong Kong and Singapore (Anson and Wang (1994, 1998), Chan and Kumaraswamy (1995); Wang, Ofori and Teo (2001), Lu and Anson (2004), and Dunlop and Smith (2003). The productivity parameters measured in all these studies and adopted in this work were type of pour, the pour size, total duration of pour, number of operatives involved, weather condition and distance from the pouRegression analysis was carried out on the observed data to determine the statistical relationship between productivity and the significant explanatory variables and to obtain probable models that will estimate productivity rates for concreting operations by crane. In this regard, the explanatory variables identified for serious variability in concreting productivity were;

- Types of pour (x1) – coded “1” for slab and beam and “2” for column and walls
- Pour size (x2)
- Fractional delay (x3)
- Weather (x4) – coded “1” for fine weather, “2” for cloudy weather, “3” for sunny and “4” for rainy weather,
- Distance to pour location (x5).

For the regression analysis, the in-built functions of SPSS 11.0 for windows was used because it allows one to store the data, perform transformations, analyze and produce charts and graphs of the results. In this instance, a regression of productivity was run on the five identified variables and examined in turn the regression results to determine the functional relationship among the variables and obtain a model that will predict productivity rates for the concreting operations. The regression analysis used is the multiple linear regression that begins with all the explanatory variables (type of pour, pour size, fractional delay, weather and distance to pour location) in the model, and eliminates the ‘non-significant’ variables. The expected output of the regression analysis includes the:

- ANOVA table which signifies the acceptability or otherwise of the regression results.
- Model summary table, which indicates the strength of the relationship between the model and the variations in the dependent variable.
- ‘Coefficients’ table which displays the values for predicting the dependent variable given the scores of the independent variables and using the ‘Unstandardized Coefficients’ as the values for the constant and the coefficients of the variables.
- Table of correlation coefficients between all pairs of the explanatory variables, including productivity, which indicates the relationships between the variables and confirms the appropriateness or otherwise of the regression coefficients earlier mentioned.

A set of the regression analysis and correlation coefficients matrix was computed for the set of Multiple Regression Analysis (MRA) performed to explain the effectiveness of the five responsive parameters on productivity, the regression was of the form

Productivity (P) = a + b1x1+b2x2+b3x3+b4x4+b5x5----------- (1)

For all the pours, the overall productivity and labour productivity were expressed in cubic meter per hour and worker hour per cubic meter respectively.

III. Analysis and Discussion

Table 1 summarises the data and productivity characteristics that were observed and calculated for the 35 pours. This is made up of 22 pours for beams & slab and 13 pours for columns & walls. The calculated quantities are the fractional delay as well as the productivity (overall and labour) values as indicated in the table. The total pour size observed was 1455.65m3 with mean pour of 41.60 m3. The mean overall productivity was 11.24 m3/hr while labour productivity was 4.09 m3. The overall productivity of 11.24 m3/hr obtained in this study compare favourably with 12.2 m3/hr for 43 craned pours in Hong Kong with a mean pour size of 89 m3 (Anson and Wang,1998), and 11.3 m3/hr for 10 similar pours in Hong Kong with a mean pour size of 49 m3 (Chan and Kumaraswamy, 1995).

The ANOVA results are shown in **Table 2** where the last column of the table titled “Sig” shows that the “Goodness of Fit” is less than 0.05. This means that the model fits the data and hence the variations explained by the model are not due to chance. The summary of the ANOVA table indicates that the model is significant at 0.000 level which is less than the chosen confidence level of 0.05 and therefore acceptable.

Table 3 is the coefficients of the first run regression on actual productivity and displays the statistics of each explanatory variables and the significance of the “t” statistics. From the table, only the variables: type of pour (x2), pour size (x3), and fractional delay (x4) were significant because their “Sig” values are less than 0.05 or 5% error of estimation.

Table 1: Summary of data and calculated productivity characteristics for each type of pour

Type of Pour		Pour Size (m^3)	Delay (mins)	Total Duration (hr)	Fract Delay	Number of Operatives	Distance to Pour Location (m)	Overall Productivity (m^3/hr)	Worker-hour per m^3
beam & Slab	Sum	1319.2000	1222.88	92.72	4.31	443	278.00	333.24	55.21
	Mean	59.963636	55.5855	4.2146	0.1958	20.14	12.6364	15.1473	2.5096
	N	22	22	22	22	22	22	22	22
Columns & wall	Sum	136.4480	523.29	34.08	2.35	168	10.00	60.19	88.02
	Mean	10.496000	40.2531	2.6217	0.1804	12.92	0.76692	4.6300	6.7710
	N	13	13	13	13	13	13	13	13
Total	Sum	1455.6480	1746.17	126.80	6.65	611	288.00	393.43	143.23
	Mean	41.589943	49.8906	3.6229	0.1901	17.46	8.2286	11.2409	4.0924
	N	35	35	35	35	35	35	35	35

Table 2: ANOVA statistics of regression on actual productivity – first run

Model	Sum of Squares	df	Mean Square	F	Sig.
1. Regression	2409.366	5	481.873	6.541	.000[a]
Residual	2136.266	29	73.664		
Total	4545.632	34			

a. Predictors: (Constant); Distance to pour location (m); Pour size (m3); Fractional Delay; Weather; Type of Pour.

Table 3: Coefficients of regression on actual productivity – First run

	Unstandardized coefficients		Standardized coefficients		
Model	B	Std.Error	Beta	T	Sig.
1 (Constant)	26.34	6.749		3.903	0.001
Type of Pour	-9.208	3.392	-0.39	-2.715	0.011
Pour Size (m^3)	5.06E-02	0.023	0.305	2.244	0.033
Fractional Delay	-28.267	7.842	-0.482	-3.605	0.001
Weather	1.348	2.237	0.082	0.603	0.551
Distance to Pour Location (m)	-9.48E-02	0.079	-0.167	-1.201	0.24

Table 4: Correlation coefficients between all pairs of variables – First run

	Overall Productivity	Type of pour	Pour size	Fract Delay	Weather	Distance to Pour Location
Overall productivity	1.00					
Type of Pour (x_1)	- 446	1,000				
Pour size (x_2)	.433	-348	1.000			
Fract Delay (x_3)	- 452	- 038	.004	1.000		
Weather (x_4)	.238	- 189	.039	-241	1.000	
Distance to pour (x_5) Location	.081	-286	.058	-199	.280	1.000

Table 4 displays the correlation coefficients between the pairs of variables for the first run regression on productivity and shows how their separate effects on the response variable can be determined. Since the objective is to determine the factors influencing productivity significantly, emphasis was placed on identifying the variables that are highly correlated with productivity. A glance at Table 4 shows that only the correlation coefficients (positive or negative) of each of type of pour (x_1), pour size (x_2), and fractional delay (x_3), were high enough (i.e. above 0.250) to be considered to have important relationships with productivity. It was therefore necessary to carry out further runs of regression, eliminating the insignificant variables, weather(x_5), and distance to pour location (x_6),one after the other from the regression analysis until a final run in which all the variables that were left have "Sig" values less than 0.05 and were significantly correlated with productivity. The resulting ANOVA statistics, coefficients of regression and correlation are shown in Tables 5 and 6 respectively while correlation coefficient between all pairs of variables(final run) is shown in **Table 7.**

The F-ratio for the final run regression on productivity shown in Table 5 is 10.516, which is higher than the critical F-ratio of 2.92 at a significance level of 0.5%, F (0.05, 3, 31).

Table 6 shows the coefficients and t-statistics for the final run and indicates that the final run regression equation model viewed becomes

Productivity (P) = $25.817- 8.391x_2 + 0.052x_3 - 27.410x_4$ --- (2)

This equation also confirms that the key determinants of productivity for craned pours were type of pour (x_1), (at 0.013 level of significance), pour size, (x_2) (at 0.028 level of significance), and fractional delay (x_3), (at 0.001 level of significance). The "Beta" column of Table 6 which contains the standardized coefficients reveals that fractional delay with a value of 0.467 (-) is the most powerful predictor of productivity, followed by type of pour with a score of 0.356 (-) and lastly by pour size with a score of 0.311 (+).

Table 5: ANOVA statistics for regression on actual productivity -Final run

Model	Sum of Squares	df	Mean Square	F	Sig.
1. Regression	2292.722	3	764.241	10.516	.000[a]
Residual	2252.910	31	72.675		
Total	4545.632	34			

a. Predictors: (constant), Fractional delay, Pour size (m^3), Type of pour

Table 6: Coefficients of regression on actual productivity - Final run

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig
	B	Std. Error	Beta		
1 Constant	25.817	5.228		4.938	0.000
Type of Pour	-8.391	3.183	-0.356	-2.636	0.013
Pour size (m^3)	5.15E-02	0.022	0.311	2.304	0.028
Fractional. Delay	-27.41	7.426	-0.467	-3.691	0.001

Table 7: Correlation coefficient between all pairs of variables – Final run

	Overall Productivity	Type of Pour	Pour Size	Fractional Delay
Overall productivity	1.000			
Type of pour	-.446	1.000		
Pour size	.433	-.348	1.000	
Fractional delay	-.452	-.038	.004	1.000

IV. VALIDATION OF THE DERIVED MODEL

The regression model obtained was validated using actual concrete pours from other projects in the study area so as to determine their practicality for use on projects. The concrete pours used for validation were poured using the same placing methods and procedures in the study. The actual productivities achieved on 13 operations (about a third of the 35 craned pours in the study) were compared with the predicted/calculated productivities using the derived regression model as shown in Figure 1. The figure shows the following three distinctive sections or areas:

1. Firstly, for those pours of low productivity (productivities of about 5m^3/hr and lower), the model provides the least accurate values of productivity and return an average difference of 28% between the calculated and actual productivities. All these are beam and slab pours and considering that the beam and slab pours used to derive the regression model yielded the highest productivities at an average of 15.15m^3/hr,the obtained model may be poor at predicting productivities at these low levels and appears to overestimate them.
2. The second area concerns the seven pours which show more accurate predictions with the regression model and return an average of about 18% difference between the calculated and actual productivities. All these are also beam and slab pours, showing that the model appears to be fairly accurate when dealing with higher productivities in the range 15m^3/hr and above.
3. The last section is made up of the 3 wall and column pours. Wall and column pours generally return low productivities due to the fact that concrete into these structures have to be poured slowly in a controlled manner. It is however difficult for the regression model to replicate all the specific characteristics of wall and column shapes and this appears to be the reason that the model underestimates the productivities of these pours at an average difference of about 20% between calculated and actual values.

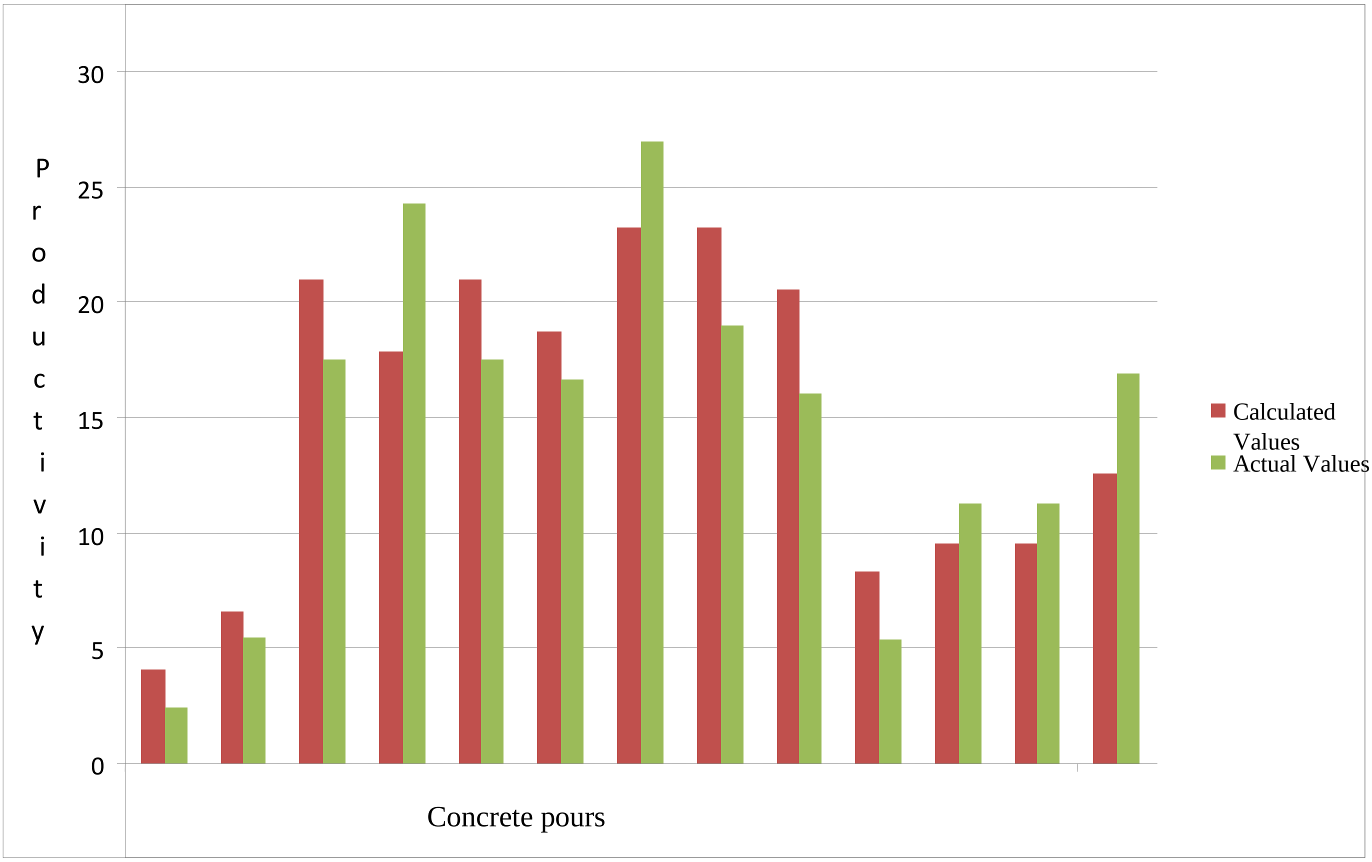

Figure 1: Values of calculated and actual productivity (m^3/hr) of craned pours used for validation

V. Conclusions

This study has analysed data collected directly from observations made on 35 concreting operations placed by cranes in 25 building construction sites in Lagos, Nigeria. The 35 concrete pours observed comprised of 22 pours for beams and slab and 13 pours for column and walls. The result of the analysis has shown that the productivity of concrete pour by crane in the Nigerian construction industry compare favourably with some other developing countries especially in Hong Kong that was used as a benchmark.

Five variables identified as influencing concreting productivity in the literature were investigated and these variables were entered along with concreting productivity for multiple regression analysis.

Deductions were based on evidence obtained from ANOVA and correlation analysis results of the best-fit run of the multiple regression analysis. The ANOVA technique helped to identify the factors affecting concreting productivity while the correlation analysis helped to explain these factors in terms of strength of association between variables. A productivity predictive model was subsequently developed for all the craned pours by stepping through each of the identified variables one by one using the multiple regression analysis. This model was validated by applying results of actual concrete pours from different projects. The validation exercise demonstrated that the model produced fairly good results for productivities greater than $5m^3$/hr but was quite poor for predicting productivities less than $5m^3$/hr.The regression analysis and model showed that the most significant variables are type of pour, pour size, and fractional delay (delay time expressed as a fraction of the pour duration).

These identified factors affecting the concreting productivity of craned pours are clear signals to the Nigerian construction industry of factors to be aware of in planning concreting operations by crane. Identifying these factors is an essential step in reducing their impact on concreting productivity through proper planning, work scheduling, coordination and control.

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An Innovative Approach for Quality Improvement in Engineering Education

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GJRE Classification (FOR) 091503, 130306, 130313 & 130103

Abstract - Since the quality of university education has become a subject of major concern, it has become evident that universities will have to board on systematic quality if they want to survive in the global education market. In this paper, a statistical process control model is developed for monitoring, control and improvement of the teaching process and learning outcomes. This model has considered lectures, tutorials and laboratory experiments as the most common constituents of an engineering undergraduate course. Using this approach, universities are able to make the claim for exceptional student performance and/or disprove the claims that their instructional systems are the cause of poor student performance. A case study regarding the issue discussed has illustrated a remarkable reduction of critical students' errors in a mechanical engineering laboratory.

Keywords- Background Knowledge Probe (BKP), Classroom Assessment Techniques (CAT), Total Quality Management (TQM

I. Introduction

In the last decade, the quality of university education has become a subject of major concern. Students, their families, companies, the graduates, university professors and staff, the government and politicians, al1 have interests and stakes here. Numerous programs have been started to improve quality, Total Quality Management (TQM) being an example. Governmental and professional institutions have introduced the accreditation of university programs, in order to provide the standardization at a national level. Now the questions arise 'What does quality in education mean?', 'How can universities assure the general public of the quality of educational services provided?', 'How can universities improve quality?' [1]

A quality system is a set of interdependent processes that function amicably, using various resources to achieve objectives related to quality and create quality characteristics that will meet customer needs [2]. An established quality system requires certain resources, such as people, material and information, to achieve set goals and objectives. Organization, responsibility, authority and interrelationship between people whose work affects quality of the product must be defined. Documented resources are also needed to describe and control processes within the quality system, and to provide evidence of an effective and efficient quality system to interested parties, such as customers, external organizations or management. The ISO 9001 quality system in a university department, through process control, statistical techniques and internal quality audits can achieve an objective of creating zero-defect students, which would at this point of time certainly surpass the expectations of its customers.

II. Quality control and improvement

Quality control of the common constituents of an Engineering course: lectures, tutorials and laboratories are addressed, followed by a description of the tools for quality improvement. Students are continuously tested through term tests, assignments, projects, quizzes and exams. Term-tests and exams resemble the 'go-no-go' gauges [3]. Rather than comparing a student's knowledge and competence with the performance of his/her class peers, it should be compared against an established standard. Quality knowledge and competence must be built into students, and not just inspected at the end of a course or program. If there is any inspection and testing to be done, it should be done continuously before and after every lecture, laboratory and tutorial, much like in the Toyota production system where a product is continuously inspected after each operation and before every consecutive operation. Techniques such as Statistical Process Control (SPC), Analysis of Process Capability, Acceptance Sampling, or the 'Seven Quality Control Tools', together with established classroom assessment techniques, can be used to build in quality on a continuous basis [4].

III. Quality control in lectures

Combining Classroom Assessment Techniques (CATs) [1] with control charts provides the possibility to control learning outcomes and the teaching process. In this a modified Background Knowledge Probe (BKP) is used to measure the learned material, together with plotting a control chart of results as a statistic. A BKP requires students to write short answers and/or circle the correct responses to multiple choice questions, and provides feedback on students' poor learning [5]. A modified BKP for a lecture would ask the students about their prior knowledge on the matter to be taught at the beginning of a lecture, but would also ask the same questions at the end of a lecture.

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For example, the one question isanswered correctly by 19 out of 48 students before the lecture and 47 after the lecture, with 28 students who learned the answer during the lecture. On average for the lecture, 90.4% were correct after, with 52.5% whose learning can be attributed solely to the lecture. If a professor wishes to observe the performance on each individual question, an attribute 'p' chart can be used with the p_c and/or p_L statistics directly plotted for each question. This chart can also be used in the examination of performance from lecture to lecture.

A. Implementation Procedure for a P-chart

Step 1: For each question in BKP, record the number of students who were wrong or did not know the answer before and were correct after (L_i), as well as the total number of students (n_i).

Step 2: Treat each question as a subgroup (sample), and the number of students who answered each question as the size of the subgroup (n_i).For instance, if 25 students answered the first question and 24 answered the second one, then n_1=25 and n_2 = 24. Evidently, subgroup size may change from question to question and will most certainly change from lecture to lecture, depending on the number of students attending. The number of questions given represents the number of subgroups (g).

Step 3: If we assume that there is an equal probability of each student being wrong before and correct after, that the students are independent of each other, and a sample of n students is taken, then the statistic p_L should be binomially distributed. Thus, a p-chart with the following central line: CL = p where $p=(\sum L_i)/(\sum n_i)$, i=1,2, ...,g, and control limits: $p\pm3(p(l-p)/n_i)^{0.5}$ is plotted. These limits can be established after about 25 subgroups, i.e. 25 questions. For example, if each BKP contains 5 questions, a p-chart can be plotted after five lectures.

Step 4: Plot the proportions p_{Li}= Li / n_i on the chart.

Step 5: Identify assignable causes of variation.

Step 6: Eliminate points for which assignable causes of variation have been found. Recompute the control limits and continue monitoring the teaching/learning process.

B. Case Study

The above-mentioned approach has been used to monitor and control classroom Lecture in mechanical engineering course. A modified BKP with five questions (n=5) has been applied in nine (g=9) lectures. Classroom attendance has been in the 35-50 range. A p-chart drafted for the p_L statistic (Figure 1) shows three points, corresponding to questions #10, 32 and 37 well below the lower control limits, indicating out-of-control conditions. The analysis illustrates that all three questions were numerical in nature, requiring the students to apply the knowledge of several theoretical concepts to solve the problem. Low output may indicate that students did not have the time or motivation to solve these problems (it did not count for marks), but also that more emphasis should be given to practical applications of theory.

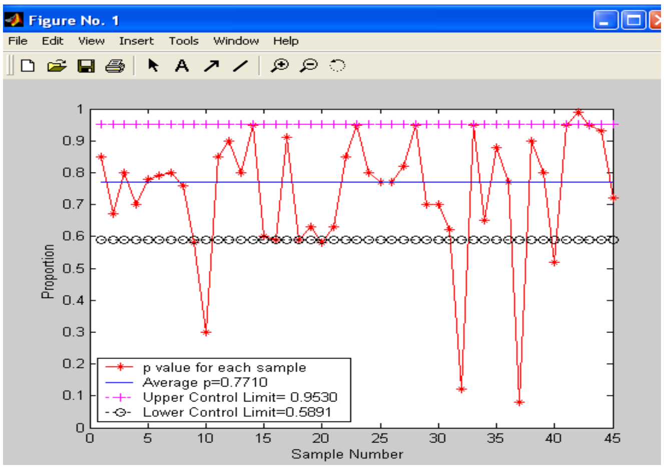

Fig 1: p-Chart for Lectures

IV. Quality control in laboratories

A. Approach

Laboratory experiments in engineering education differ from classroom lectures in that a class is usually divided into smaller groups of students. Also, contrary to lectures, which present new material with each new lecture, laboratory experiments are repetitive in the sense that each group of students is required to perform essentially the same experiment. Nevertheless, the approach to quality control in laboratories is similar to the one for classroom lectures [7]. Since the measured parameters are counts, and the number of students in each laboratory session can vary, a u-chart for defects per session is suggested [8]. First, the average number of defects (say incorrect answers after the session) for each laboratory session $u_j= (\sum c_i)/ n_j$, is calculated. Here, i = l, 2, . . ., n_j denotes an individual student in the j-th group; c_i is the count of either the incorrect answers for each student or the number of questions with an incorrect answer before and a correct answer after for each student; n_j is the number of students in each session; and j=1, 2, ..., g is the number of laboratory sessions. After these calculations, the center line is established as $u^* = (\sum \mathbf{U_j}) / g$,, control limits as $u^* + (u^*/ n_{j)})^{1/2}$, and control charts plotted and analyzed. The analysis of out-of-control conditions is similar to the classroom lecture case

B. Case study

The approach for quality control in a laboratory setting was studied using a second year mechanical engineering (Thermodynamics) course [6]. Students were divided into 16 groups of 7 students in average, each group performing a 1 hour-long experiment on a different day. The BKP was applied at the beginning and end of each session. Groups of student performing the experiment on a particular day were treated as subgroups (g=16), with a variable subgroup size due to the fact that some students were not able to participate on a scheduled date. Thus, 'n' varied from 4 to 9. A u-chart was drafted for the statistic (Figure 2). The control chart indicates in control conditions, with a downward trend on the chart for the first seven groups. The students might not have had enough time to read lab notes before the session, causing the statistic to fluctuate at a higher level.

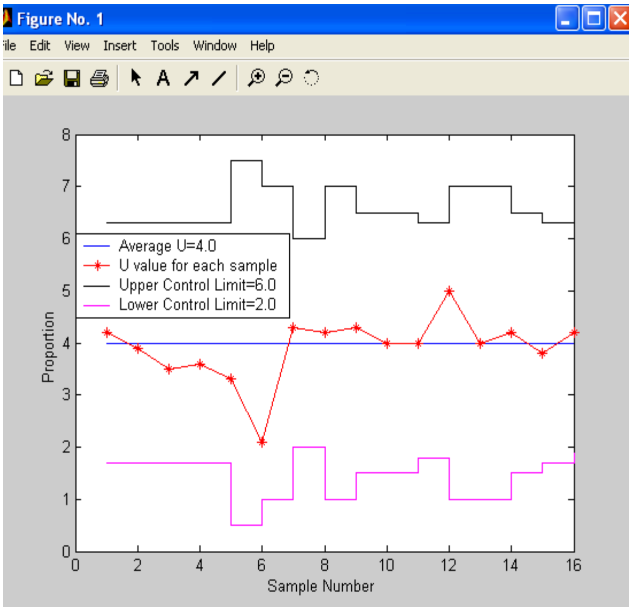

Fig 2: U-Chart for a Laboratory

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V. Quality control in Tutorials

A. *Approach*

When a tutorial consists of a professor solving numerical problems, the same approach that is used for a lecture can be applied, with the BKPs (background knowledge probe) emphasizing numerical questions or analytical abilities. However, when an assignment to be handed in at the end of a tutorial is given to students, the professor can use a different approach. Instead of using a knowledge probe, errors in the assignments can be recorded and monitored. A total number of errors for each assignment or the occurrence of a particular error can be traced. This can be done with a 'u' chart, which monitors the average number of nonconformities per unit. If for example, n_i=50 students made a total of c_i =100 errors in assignment 'i', the average number of errors is $u_i = c_i / n_i$ = 100/50 =2. Statistic u_i is plotted on a chart with $u^* = [(\sum u_j) / g]$ as a central line (*g* is the number of assignments or problems), and $[u^* \pm 3x\ (u^*/n)^{1/2}]$ as control limits. The u chart allows for changes in the subgroup size, i.e. the number of students attending each tutorial.

B. Case Study

A tutorial in a first year elements of mechanical engineering course has been used. The tutorial is planned as a one hour session with the professor assisting students individually in solving numerical problems. Subsequently, each student is required to solve a given problem (the same problem for ail students) and submit the solution to the professor, who then makes corrections and marks the solutions. The total number of errors the students made for each such assignment was recorded, and the results plotted on a u-chart (Figure 3).

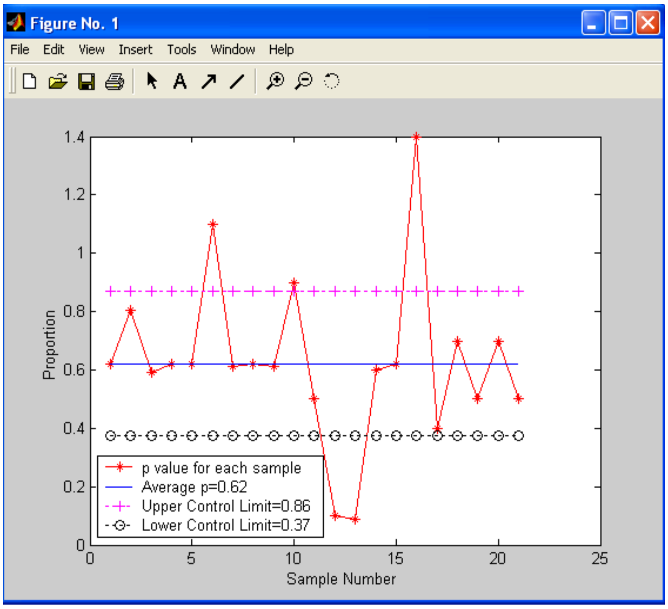

Fig 3: U-Chart for the Number of Errors in Tutorial Assignments

For example, in assignment *#2*, 13 students did not make appropriate assumptions, 25 students missed appropriate units for properties, and 36 students used a wrong table to find a property. Thus, a total of 74 errors were recorded from 92 students, yielding u=74/92=0.804. As a note, each student can make multiple errors, and thus a 'u' chart is used. The u-chart in Figure 3 indicates *5* points outside control limits. Assignments # 6 and 10 had a high number of errors concerning missed statement and/or assumptions, and students making an argument that they did not know they were supposed to identify these assumptions. Assignments #12 and 13 were not difficult, with only a few calculations required, and thus had very few errors. Finally, assignment #16 simulated a problem that could be given on a final exam, required a large number of calculations and was worth three times more in terms of marks than that of al1 other assignments

VI. Conclusion

Using this approach, universities are able to make the claim for exceptional student performance and disapprove the claims that their instructional systems are the cause of poor student performance. Some of the benefits of this approach include:

- Information on the incoming variation in student ‘baseline’ knowledge is provided

- .Information on how much and how well the students have learned the material is provided'
- Before' and 'after' knowledge can be compared to roughly estimate the value-added outcome.Effects such as when a student knew the answer before but not after can be examined.
- Students are focused on the most important issues in a lecture.
- The case studies regarding the issue discussed have made a remarkable reduction of critical student's errors in mechanical engineering class.

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Natural Convection Heat Transfer inside a Porous Triangular Enclosure with baffles

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GJRE Classification (FOR)
090703, 090502, 091005 & 020304

Abstract: **Simulation is presented for two dimensional natural convection heat transfer and fluid flow inside a porous triangular enclosure having two conducting solid baffles. The equations of mass, momentum and energy are written using Darcy model. These equations are discretized using finite difference method. The resulting algebraic equations are relaxed with successive under relaxation approach. The flow and thermal field characteristics are investigated under different parameters such as baffle location, baffle height, baffle width and Rayleigh number. The obtained results show that a multi cellular flow has been obtained for** $Ra \geq 150$ **along with increased deviations of stream lines. Also the results verified that the conducting baffles have a significant effect on the flow and heat transfer. The present Numerical results for isotherm and streamlines are compared with available published results and a good agreement has obtained.**

Keywords: baffles, Porous media, Triangular enclosure, Natural convection

I. Introduction

Natural convection heat transfer and fluid flow in enclosed enclosures has received a great deal of attention in the academic research due to its diverse applications in many engineering and technological applications. These applications include solar collectors, nuclear reactors, ventilation, cooling of electronic devices and geothermal applications. These enclosures may be classified as porous or non porous enclosures. Most of published research activities were focused on natural convection in rectangular or square enclosures. Few studies were reported on non-rectangular porous enclosures because the computations in these enclosures are not performed easily. When the previous studies are reviewed, one can see there is no study was performed on natural convection in a porous triangular enclosure with baffle. So this work tries to motivate the academic research in this field and show how the presence of conducting baffles can effect on the flow and heat transfer. Kandaswany et al. [1] investigated natural convection inside a square cavity in the presence of heated plate. Their study showed that the heat transfer rate was increased with the increase of Grashof number in both horizontal and vertical position of the plate. Kangni et al. [2] performed a theoretical study on laminar natural convection and conduction in enclosure with multiple vertical partitions. They demonstrated that the heat transfer was decreased with increasing of thickness and number of partitions. Moez et al. [3] presented a numerical study on natural convection in a trapezoidal cavity. They showed that a multi-cellular flow patterns start to form when the aspect ratio increased. The flow and thermal field in an isothermal vertical wavy enclosure was studied by Mahmud et al [4] for different Grashof numbers and orientations. Khalil et al. [5] analyzed the natural convection heat transfer in a wavy porous enclosure using non-Darcian model. They found that the amplitude of the wavy surface and the number of undulation affected the heat transfer characteristics. Hasnaoui et al. [6], Ben-Nakhi and Chamkha [7], Dagtekin and Oztop [8] investigated also the natural convection in enclosures with a partition. The presence of a partition was the effective parameter on heat transfer. Collins [9] did a numerical study on heat transfer in a square cavity with a baffle located on the hot wall. The study showed that the baffle has a significant effect on increasing the rate of heat transfer compared with a wall without baffle. The natural convection analysis for flush-mounted heaters located in triangular enclosure was studied by Koca et al. [10]. The study showed that the heat transfer was improved when heaters is close to the right corner. Yasin et al. [11] studied the laminar natural convection in porous media right-angle triangular enclosures. His study showed that the heat transfer was increasing with decreasing the aspect ratio. Baytas and Pop [12] to investigate the natural convection in a porous horizontal enclosure performed a numerical study. They solved darcy and energy equations adopting alternative direction implicit finite difference techniques. The results showed that the conduction heat transfer zone is dominant for low Rayleigh numbers. Yasin et al [13] conducted a numerical study to investigate the 2D laminar natural convection in a porous triangular enclosure with a square body. They showed that the fluid flow and temperature fields are strongly dependent on thermal boundary conditions of the body. Fuad et al. [14] studied the laminar natural convection inside right triangular enclosures. Abdalla et al. [15] analyzed the mixed convection heat transfer in a lid-driven cavity with a sinusoidal wavy hot surface. The results of this study showed that the average Nu is increased with an increase of amplitude of the wavy surface and Reynolds number.

In this paper, the 2D laminar natural convection heat transfer and fluid flow inside a partitioned porous triangular enclosure has been studied. Two solid conducting baffles are used while the remaining area are filled with porous media as shown in Fig.1. The working fluid is air. The bottom wall of the enclosure has a higher temperature than that of the inclined wall. The vertical wall is insulated. Different values of relative height of baffles is examined. Also the effect of the distance between the baffles and the baffle width is

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studied. The study was performed for Ra up to 1000 and the aspect ratio(A) is equal 0.5

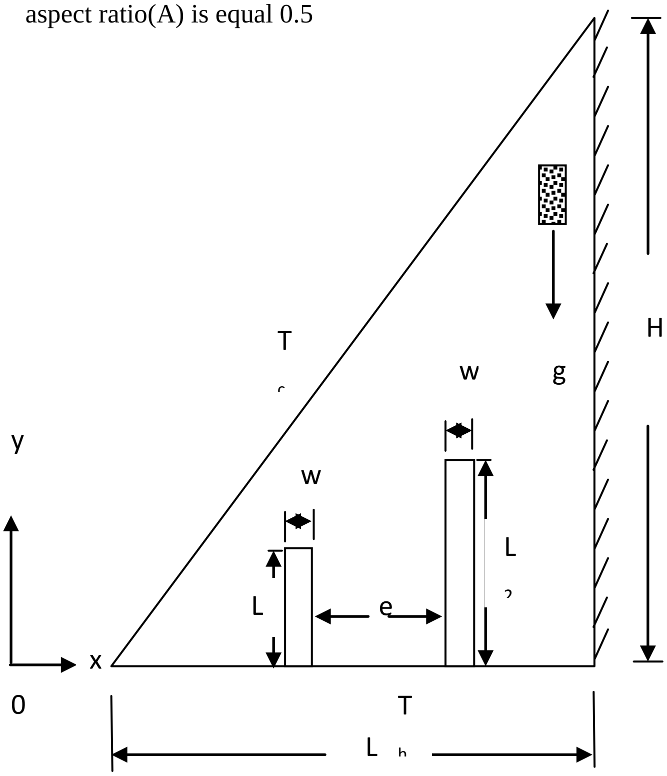

Fig.1 Schematic diagram of the considered problem

II. Mathematical Formulation

Two dimensional laminar natural convection heat transfer and fluid flow inside a partitioned enclosure is considered. The governing equations of mass continuity, momentum and energy can be described as follows:

$$\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}=0 \qquad \text{---------------(1)}$$

$$\frac{\partial u}{\partial y}-\frac{\partial v}{\partial x}=-\frac{g\beta}{\upsilon}\frac{\partial T}{\partial x} \qquad \text{-----------------(2)}$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right) \qquad \text{-----------(3)}$$

The porous media is saturated with a single phase Newtonian fluid and it can be assumed in equilibrium with the working fluid. The above equations can be written in dimensionless form after using the following parameters.

$$u=\frac{\partial\psi}{\partial y},\quad v=-\frac{\partial\psi}{\partial x},\quad X=\frac{x}{H},\quad Y=\frac{y}{H},\quad \psi=\frac{\varphi}{\alpha},$$

$$\theta=\frac{T-T_c}{T_h-T_c},\quad Ra=\frac{g\beta K(T_h-T_c)H}{\alpha\upsilon}$$

$$\frac{\partial^2\psi}{\partial X^2}+\frac{\partial^2\psi}{\partial Y^2}=-Ra\frac{\partial\theta}{\partial X} \qquad \text{-------------------(4)}$$

$$\frac{\partial\psi}{\partial Y}\frac{\partial\theta}{\partial X}-\frac{\partial\psi}{\partial X}\frac{\partial\theta}{\partial Y}=\nabla^2\theta \qquad \text{------------------(5)}$$

The temperature distribution through the conducting baffles is described as follows

$$\frac{\partial^2\theta}{\partial X^2}+\frac{\partial^2\theta}{\partial Y^2}=0 \qquad \text{-----------------------------(6)}$$

On the boundaries of the baffles:

$k_f\frac{\partial T}{\partial n}=k_s\frac{\partial T}{\partial n}$, where n a unit normal vector.

$k_f=0.026$, k_s is taken as 27 times k_f

In order to solve the mathematical model, the following boundary conditions are used

$u=v=0$, $T=T_h$, $\psi=0$ on the bottom wall [16].

$u=v=0$, $\frac{\partial T}{\partial n}=0$, $\psi=0$ on the vertical wall.

$u=v=0$, $T=T_c$, $\psi=0$ on the inclined wall.

the local and average Nusselt number along the hot bottom wall are calculated as follows.

$$Nu=-\left(\frac{d\theta}{dY}\right) \qquad \text{--------------------------------(7)}$$

$$Nuav=\int_0^1 Nudx \qquad \text{------------------------------(8)}$$

III. Numerical solution

The considered governing equations are discretized using finite difference techniques [16] . Hence the resulting algebraic equations are solved numerically using iteration method along with successive under relaxation scheme (SUR) . Uniform grids spacing is used. To ensure that the flow and thermal field are not affected by the mesh, three grids nodes densities, 961, 1681 and 2601, are used respectively. The grid nodes 2601 are adopted in this study. The computational procedure is repeated until the following convergence criteria is achieved. $\left|\phi^k-\phi^{k-1}\right|\le 10^{-5}$. The validation of this numerical method is achieved through a comparison of our results with a published one as shown in the next sections which show a good agreement.

IV. Results and Discussion

The numerical results under consideration will be reported for 2D natural convection heat transfer and fluid flow in a partitioned porous triangular enclosure. The distribution of streamlines, isotherm contours, local and average Nusselt numbers are obtained under different parameters such as, Rayleigh number, dimensionless distance (c) between the baffles, dimensionless relative height of the baffles and dimensionless baffle width while the aspect ratio (A) is assumed to be fixed at 0.5.

The distribution of stream function and isotherm contours for different values of Rayleigh numbers are depicted in Fig.2. For stream function, when Ra=50, it can be seen that there is two counter rotating cells. At Ra=150, the number of counter rotating cells are increased as shown in (b) where four cells are appeared. This increase will continue up to Ra=500, after that there is no significant change on the number of rotating cells and the structure of the flow field are noticed. The cause for increasing the rotating cells arises to increase the convective currents due to increasing the buoyancy force as a result of increasing the Rayleigh number. In this Fig., also the isotherm contours distribution for different Rayleigh numbers are depicted through (a) to (d). In (a), The isotherm lines in the conducting baffles and in a part of the enclosure are seem to be parallel and this represent a semi conduction regime. The isotherm lines distribution in both the enclosure porous mediam and conducting baffles are changed with increasing Ra as depicted in (b) to (d). The isotherm lines are not perpendicular and this arises from the free convection currents due to increase of Ra and consequently enhance the rate of heat transfer as shown in Fig 9.a. Also it can be seen that the isotherm lines are become thicker at the upper part of the second baffle and in the first baffle when Ra increases. This disclosed that the temperature gradient is increased due to the presence of hot fluid. There is no significant change in isotherm contours when Ra =1000. The stream function and isotherm lines distribution for different Rayleigh numbers and h=0.4 are depicted in Fig.3. It can be mention here that the dimensionless height of the second baffle is fixed while the dimensionless height of first baffle is changed to values of 0.2 to 0.6. As the figure shows, the relative height between the baffles has a significant effect on the flow and thermal fields. For Ra =50, three rotating cells are found as compared with Fig.2.a. When Ra =150, the number and size of counter rotating cells are seem to be similar to that found in fig.2. At Ra=500, the number and size of counter rotating cells besides location are changed especially near the first baffle. The counter rotating cells are elongated behind the second baffle and decreased in size before the first baffle. However the number of these vortices are increased and their location is changed. The isotherm lines distribution is not change for Ra=50 and Ra=150, but there is noticeable change for Ra =500 and Ra =100 especially in the region behind the second baffle. This can be shown by wavy distribution of local Nu at Fig.9.b. However the rate of heat transfer is decreased with the increase of relative height of the baffle(h) and this confirmed through Fig.13 where the average Nusselt number is decreased. Also, the relative height of the baffles (h) is changed to 0.6 for different Rayleigh numbers as depicted in Fig.4. As mentioned in the previous cases, the dimensionless distance between baffles (c) and the dimensionless width (w) are fixed. As the Figure shows, For Ra=50, there is no noticeable change in streamlines or isotherm lines. When Ra increase, there is a change of number and location of vortices besides to the elongation in the size of these vortices. Deviation of contours lines are observed due to increase the Ra and hence increase the convection currents and that also effects on the temperature distribution through the solid baffles. The effect of increasing of Rayleigh number on the rate of heat transfer is found in Fig9.c where the wavy distribution of local Nusselt is depicted. Fig.5. demonstrates the effect of dimensionless distance(c) between the baffles on the flow and thermal field for Ra=500. It can be seen that the dimensionless distance has a strong effect on the stream and isotherm lines. When c=0.35, the two counter rotating cells forming behind the second baffle are elongated to a non-uniform vorticity and appearing a secondary flow near the bottom right side of the second baffle. Also the isotherm lines distribution is changed compared with the case (a) and the temperature gradient is higher especially in the lower part of the two baffles. The rate of heat transfer is increased as shown in Fg.10.a when the dimensionless distance is increased to 0.5. The resulting vortices are changed in size , number and position. A significant change in isotherm lines is observed. The effect on heat transfer can be shown in Fig.10.a where the rate of heat transfer is increased. When the relative baffle height (h) is changed to 0.4 and 0.6, the same distribution is observed. However the rate of heat transfer is less at higher values of (h). Fig.11 shows the local Nusselt number variation for different baffle heights. It can be seen that the local Nusselt numbers is decreased with the increase of h and consequently decreasing the rate of heat transfer. Figs 6 to 7 exhibit the effect of baffles dimensionless width on the flow and isotherm field for Ra=500. It is evident when the dimensionless width (w) is increased to 0.1, the number of counter rotating cells are increased besides to appearing new small vortices. This change is increased with the increase of the dimensionless width (w). When w=0.2, two vortices are shifted above the second baffle and elongated vorticity is appeared between the two baffles. The effect also found in isotherm lines in which Fig.7 shows us the effect of a baffle dimensionless width on the rate of heat transfer. The local Nu variation on the hot wall is depicted in Fig.12. It can be shown that the rate of heat transfer is nearly decreased except some regions and the distribution is wavy. The average Nusselt number variation along the hot side is shown in Fig.13. It can be seen that the average Nusselt number is decreased with the increase of a partition (baffle) height. To perform the validation of the present numerical method used, a comparison with the available published results is made as shown in Fig. 14. As the Figure shows, a good agreement is obtained.CONCLUSIONS:

In this paper, 2D natural convection heat transfer and fluid flow inside a partitioned porous triangular enclosure are successfully simulated. The following concluding remarks are obtained.

- The rate of heat transfer is increased with the increase of Rayleigh number. However this increase becomes less for Ra > 500.

- The baffles can be considered as significant factor for controlling the heat transfer and a multi-cellular flow.
- The dimensionless distance between the baffles and the baffle width has a noticeable effect on the flow and thermal fields.
- The average Nusselt number is decreased with the increase of relative baffles height
- The local Nusselt number explained a wavy variation along the hot bottom wall.
- The rate of heat transfer is enhanced with increasing the dimensionless distance between baffles.

V. NOMENCLATURE

A	aspect ratio (H/L)
c	dimensionless distance between baffles(e/H)
g	gravitational acceleration
h	relative height of the baffles (L_1/L_2)
K	permeability
k_f	thermal conductivity of the fluid, W/m. $^\circ$C
k_s	thermal conductivity of the solid, W/m. $^\circ$C
Nu	local Nusselt number
Nuav	average Nusselt number
L_1^*	dimensionless baffle height (L_1/H)
L_2^*	dimensionless baffle height (L_2/H)
Ra	Rayleigh number
u, v	tangential and normal velocity, m/s
X, Y	dimensionless coordinates
θ	dimensionless temperatue
υ	kinematics viscosity, $N.s/m^2$
α	thermal diffusivity, m^2/s
ψ	dimensionless stream function
β	thermal expansion coefficient, 1/K
W	dimensionless baffle width (w/H)

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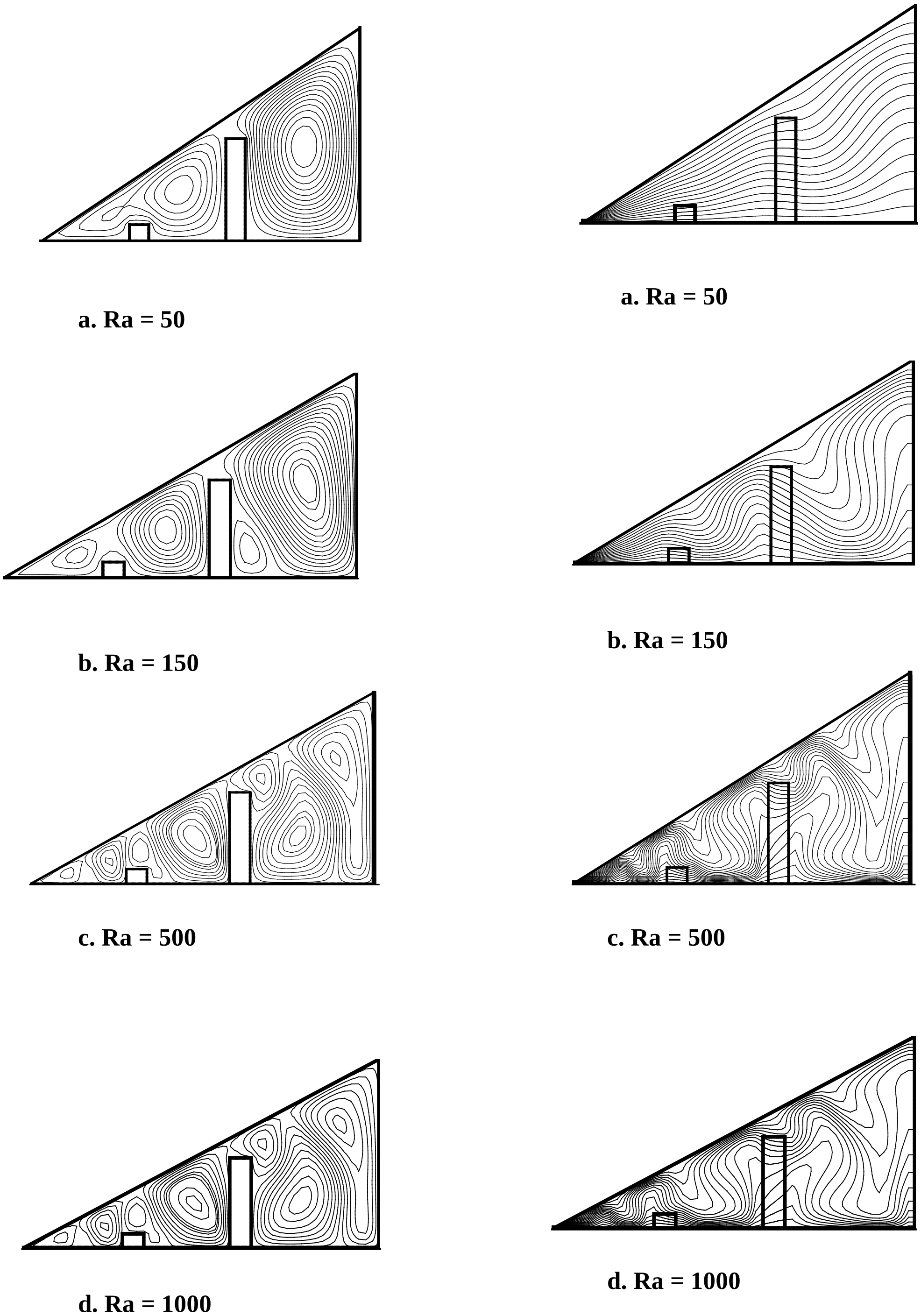


Fig.2 effect of Ra on stream function and isotherm contours for h=0.2, W=0.06 and c=0.25

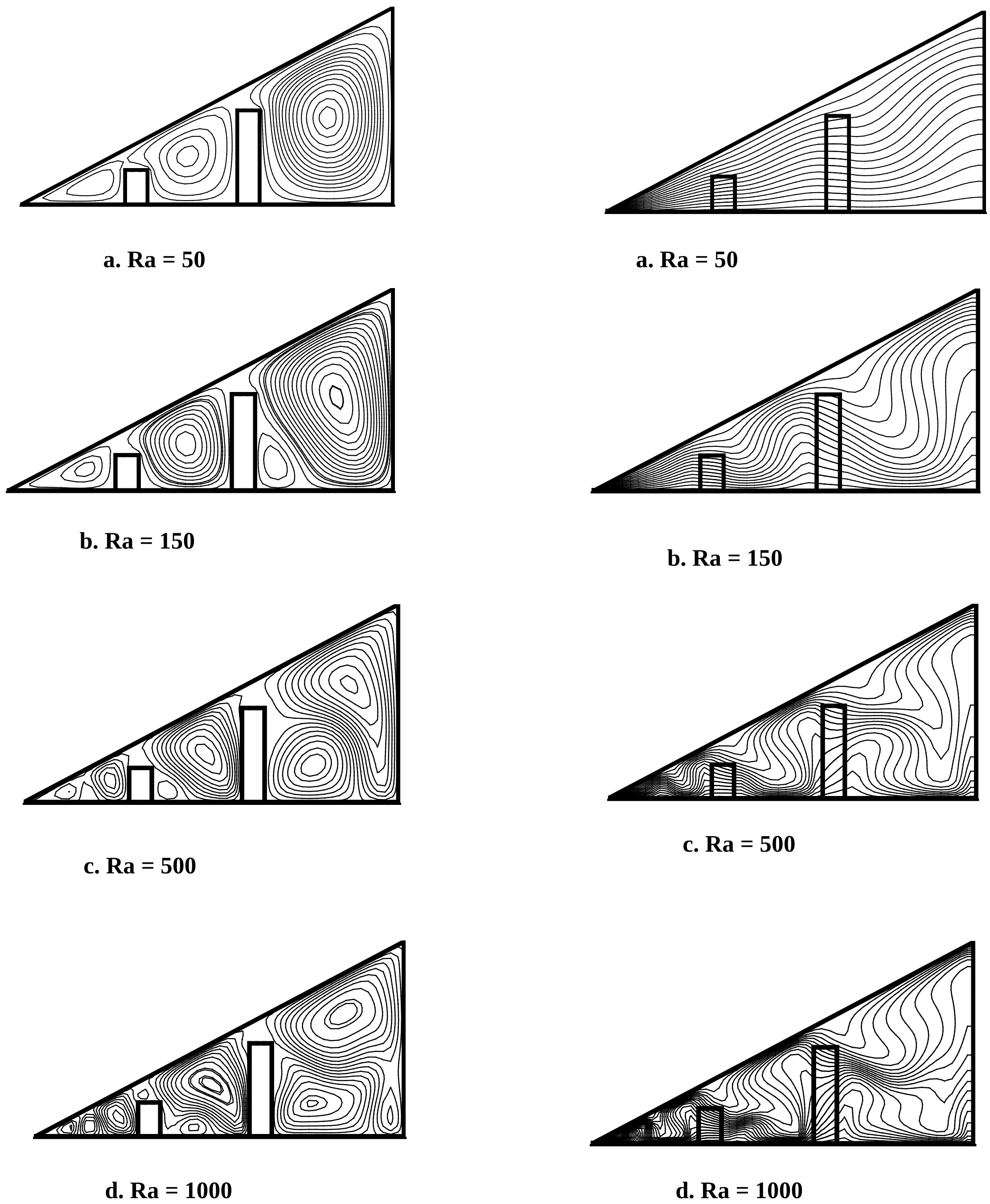
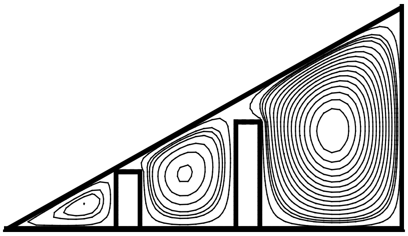


Fig.3 effect of Ra on stream function and isotherm contours
for h=0.4, W=0.06 and c=0.25



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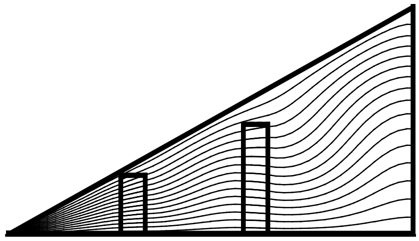

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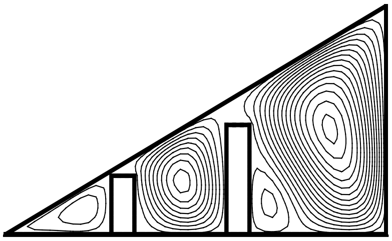

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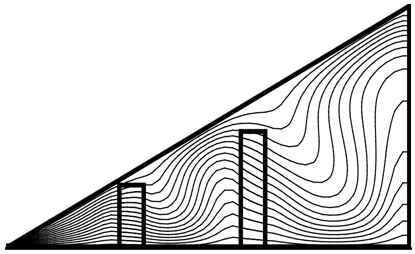

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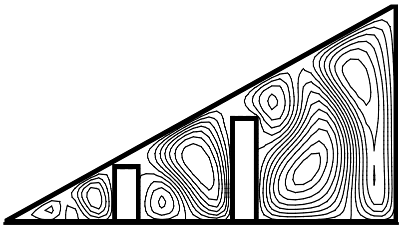
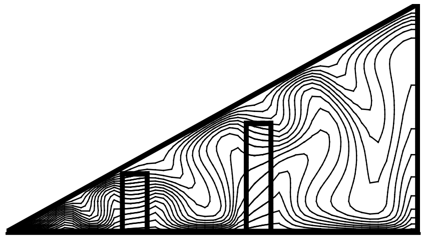
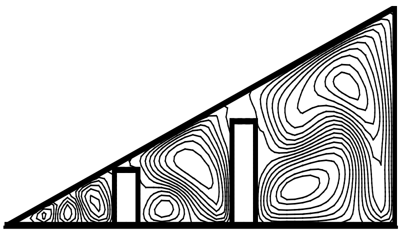


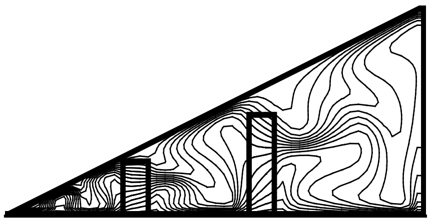
c. Ra = 500



c. Ra = 500

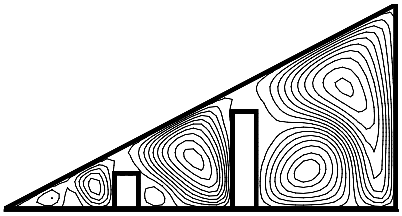


d. Ra = 1000



d. Ra = 1000

Fig.4 effect of Ra on stream function and isotherm contours for h=0.6, W=0.06 and c=0.25



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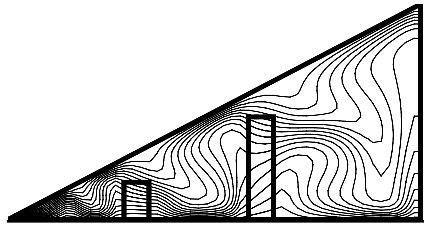

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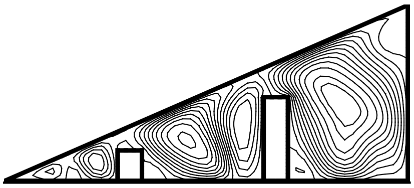

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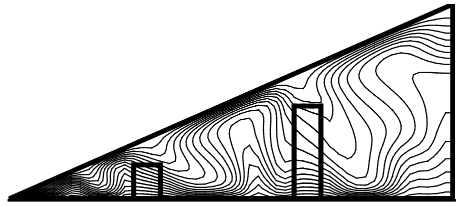

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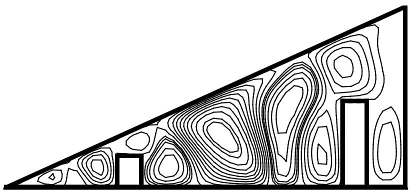
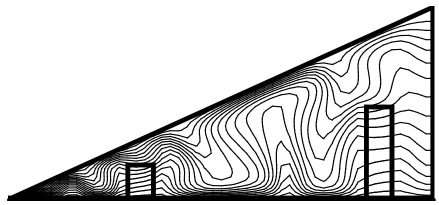
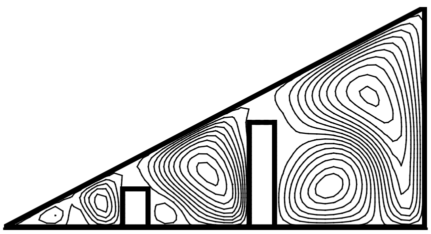


c. c = 0. 5

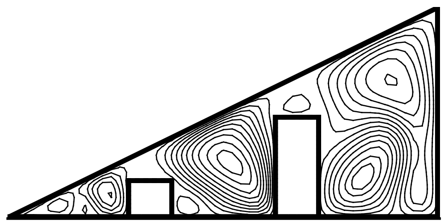


c. c = 0. 5

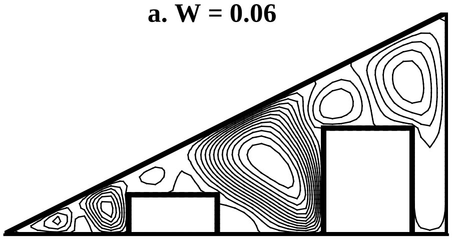
Fig.5 effect of the dimensionless distance between baffles on stream function and isotherm contours for W=0.06, h=0.4 and Ra=500



a. W = 0.06

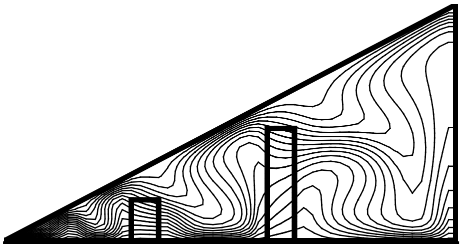


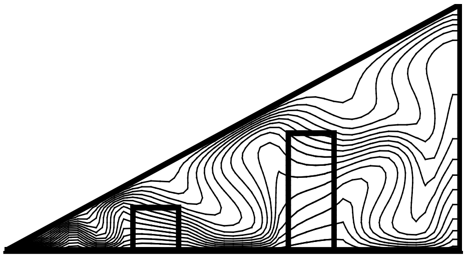
b. W = 0.1



b. W = 0.2

Fig.6 effect of partitions (baffles) width on stream function distribution for h=0.4, c=0.25 and Ra=500





b. W=0.1

a. W=0.06

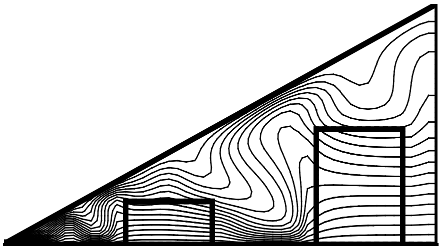
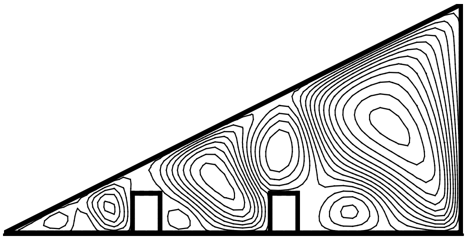
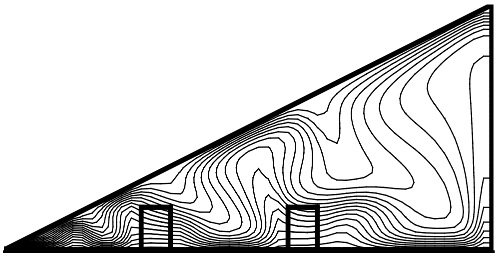


Fig.7 effect of partition (baffle) width on isotherm contours for h=0.4, c=0.25 and Ra=500

c. W=0.2

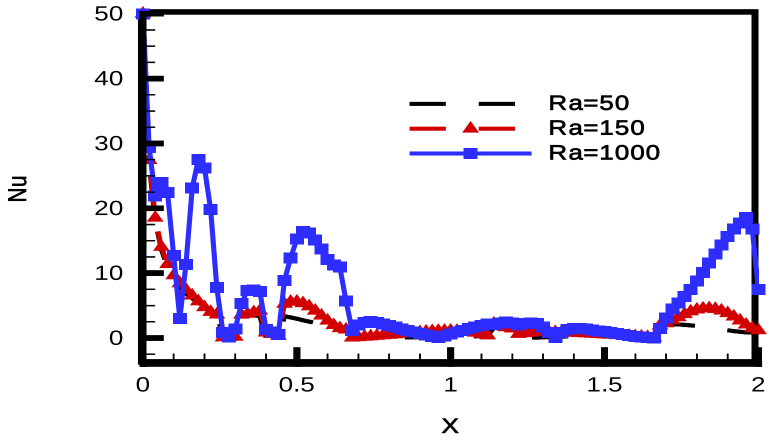




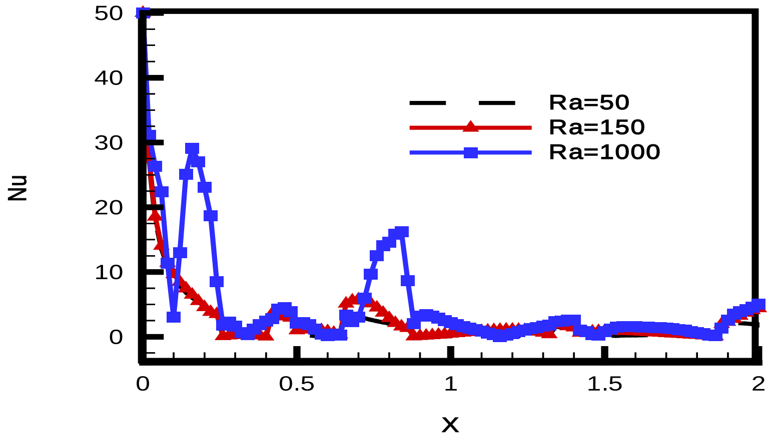
b. $L^{*}_{1} = L^{*}_{2} = 0.2$, **h=1**

a. $L^{*}_{1} = L^{*}_{2} = 0.2$, **h=1**

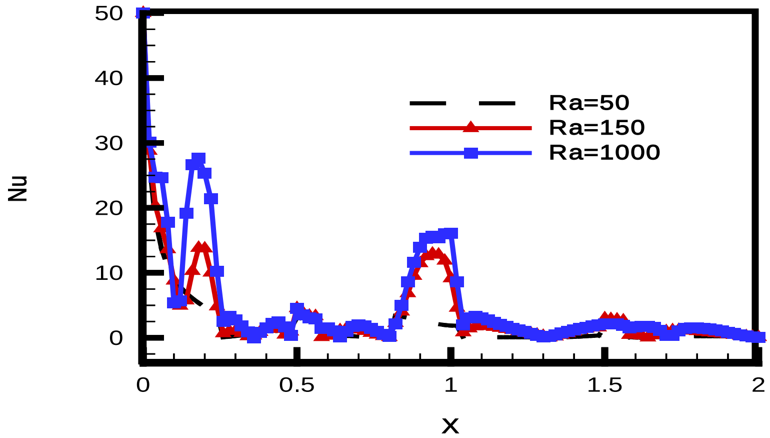
Fig.8 effect of baffles equal length on stream and isotherm contours For c=0.25, W=0.06 and Ra=500



a. h=0.2

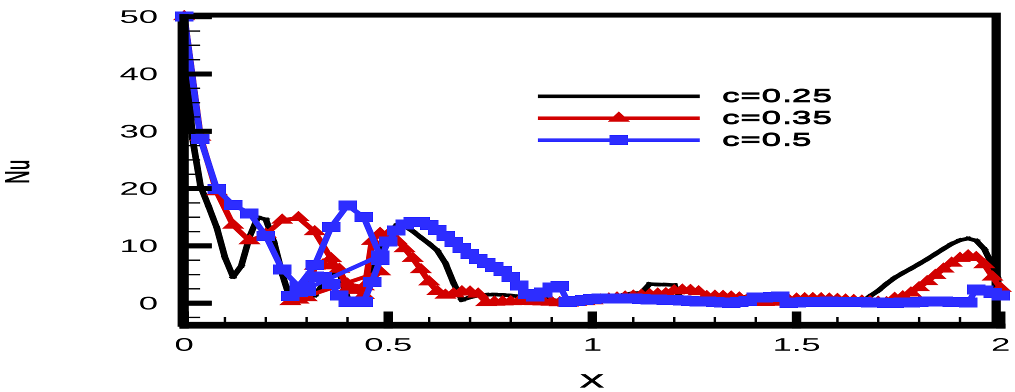


b. h=0.4

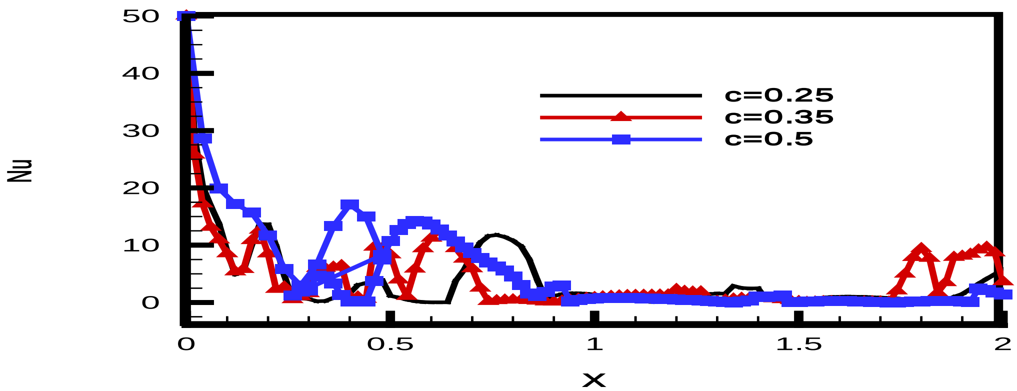


c. h=0.6

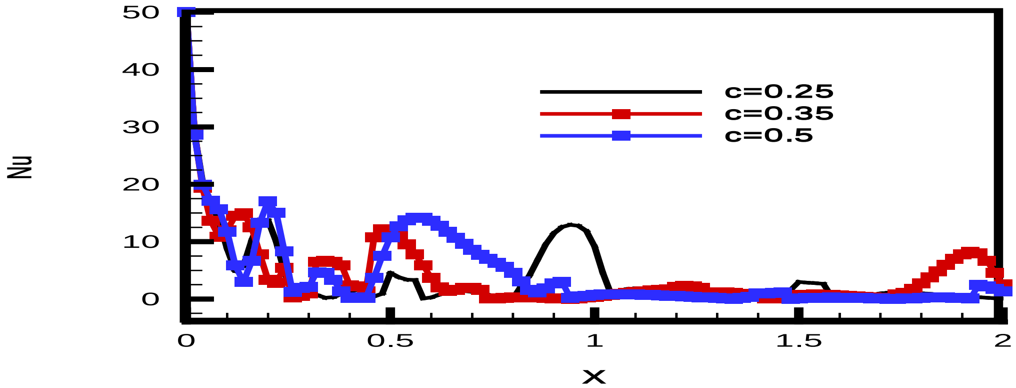
Fig.9. variation of local Nusselt number on the hot wall for w=0.06, c=0.25 and different values of Ra partition location



a. h=0.2



b. h=0.4



c. h=0.6

Fig.10. variation of Nu on the hot wall for different values of the dimensionless distance between baffles, W=0.06, Ra =500

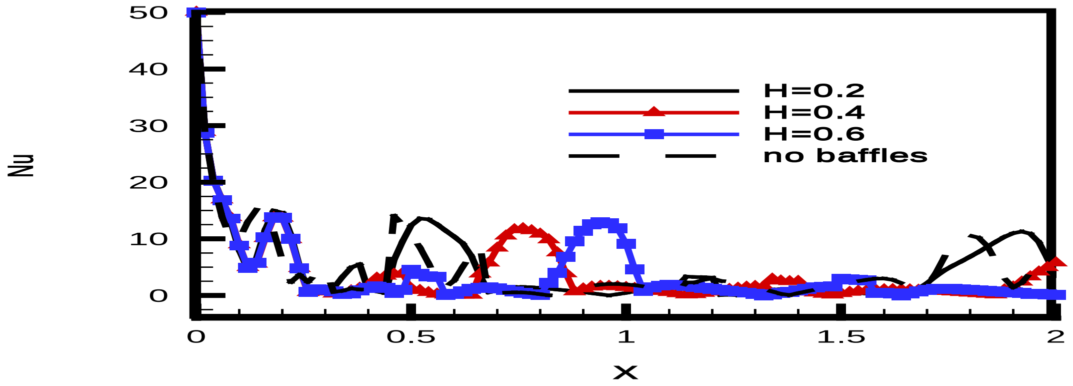


Fig.11 variation of Nu on the hot wall for different partitions heights , W=0.06, c=0.35 and Ra=500

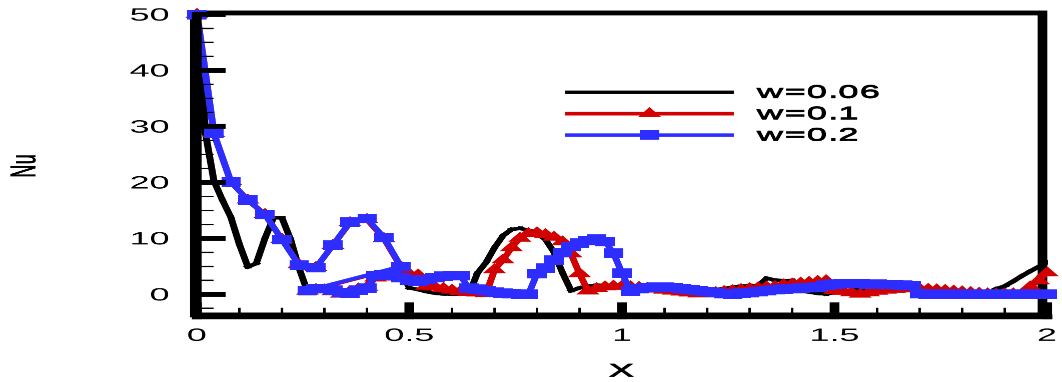


Fig.12 variation of Nu on the hot wall for different partitions widths , h=0.4, c=0.25 and Ra=500

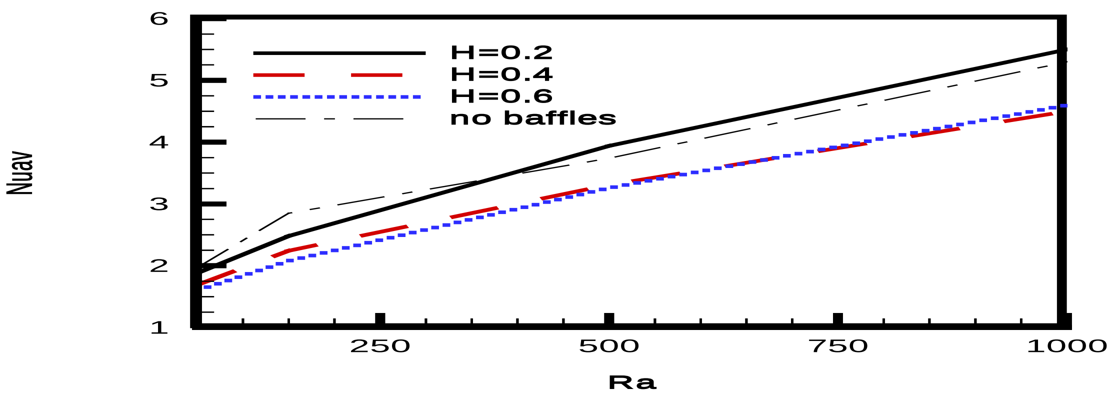
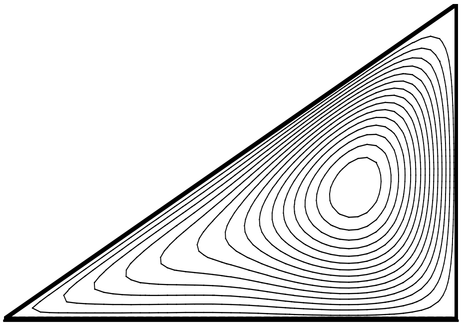
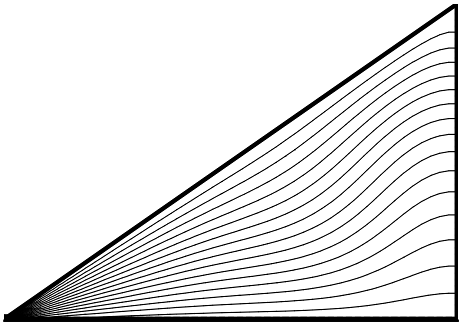


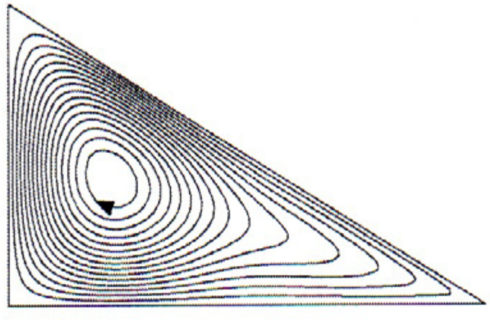
Fig.13. variation of average Nusselt number versus Ra for different values of partitions (baffles) heights, W=0.06 and c=0.35



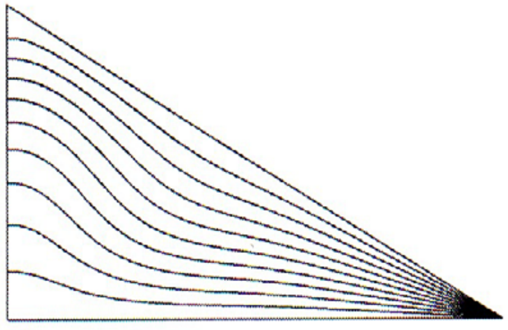
a. present results of stream function



b. present results of isotherm contours



c .published results of stream function



d .published results of isotherm contours

Fig .14 Comparison between the present and published results [11]
for Ra = 50 and A = 0.5

Removal of Cod of Reactive Dyes By Polyaluminium Chloride (Pac)

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F. K. Madan Mohan Reddy[£]

GJRE Classification (FOR)
030301, 090503, 090505 & 090403

Abstract: Poly Aluminium Chloride (AlCl3 6H2O) was used as a coagulant for the removal of Chemical oxygen demand (COD) of selective reactive dyes at different doses. The results indicate that the removal of COD of RB 41, RB 209, RB204 and RB 184 were 68, 40, 36 and 29 percent respectively at optimum doses. The optimum doses polyaluminium chloride for RB41, RB209, RB 204 and RB 184 were 5.2, 34.3, 20 and 22 mg of PAC per mg. of COD removed respectively.

Keywords: PAC Coagulant, Reactive dye removal, Coagulation / Flocculation.

I. Introduction:

The amount of dyes discharged in the world from the textile industry is about 1,46,000 tons per year(Marc, S.R, 1996). Reactive dyes are the most commonly applied among more than 10,000 dyes used in textile processing industries(Van der zee, F.P et al 2001). Reactive dyes are particularly problematic in dye wastewaters as many of these are resistant to biodegradation processes(Grau, P ,1991). Combined methods, such as activated sludge + coagulation activated sludge + adsorption and coagulation + chemical oxidation are being used by most dyeing industries(Lin, S.H and Chen, A.L, 1997, Popali G. R et al 2002). Ferric Chloride, aluminium, and lime + ferrous sulphate are widely used as coagulants for dye colour removal with varying degree of successes (Popoc, S et al 2000 Popali G. R et al 2002 Gurses, A et al 2003). However, no effort is made to optimize coagulation highly depends on the extent to which the soluble colour contributing COD can be coagulated and flocculated in addition their floc formation and settling abilities. The present investigation describe the chemical coagulation of four selective reactive dyes generally used for cotton yarn dyeing using polyaluminium chloride ($AlCl_3$ $6H_2O$). The objective of the present investigation was to removal of COD.

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II. Materials and Methods:

Coagulant: A commercial grade polyaluminium chloride ($AlCl_3$ $6H_2O$) was used a coagulant with varying doses of 0.8 to 3.0 grams / ltr.
Reactive dyes: (1) Reactive blue 41 (structure phtolocyanine (MCT)) (2) Reactive blue 184 (Structure: Azoic (MFT)) (3) Reactive blue 204 (Structure: Oxyzine (MFT)) and (4) Reactive blue 209 (Structure: Formazan (FCB)) were used as model dyes. These dyes are extensively used for cotton yarn dyeing. Dye solutions are prepared in distilled water to a strength of 300 mg/L for each dye. The COD of all the dyes are estimated as per the standard procedures (APHAS 1995).

III. Experimental System

Coagulation studies were conducted in duplicate in Jar-test Apparatus with six beakers of 01 Ltr. Capacity. A 500ml. dye solutions were taken in each beaker and different doses of PAC solutions were added. The samples were stirred for 01 minute at 300 rpm followed by 15 minutes slow mixing (25-30 rpm). The contents are then settled for 02 hours. At the end off 02 hours, the supernatant is with drawn, filtered and was used for COD analysis(APHAS 1995) .
All the experiments were conducted at a room temperature of 27 ± 3^0C.

IV. Results and Discussion:

The results of the COD analysis of the four dyes used in the experimental system is presented in Table – I.

Table – I. COD of the experimental reactive dyes

S. No.	Dye	COD (g.o2/g. of dye)
1.	Reactive blue 41	1146
2.	Reactive blue 184	842
3.	Reactive blue 204	652
4.	Reactive blue 209	796

The results indicate that exertion of COD for different reactive dyes is highly varied depending upon the dye constituents such as phenol derivatives, oniline derivatives, organic acid and benzene derivatives.

The results of the polyaluminium chloride coagulation of various dyes are presented in fig. 1 through 4. The results indicate that the removal of COD for each dye is highly Varied, indicating that the solubility of these dyes in water is quite different. The performance of COD removal by chemical coagulation depends upon the solubility of the dyes in water. The reactive dyes which are

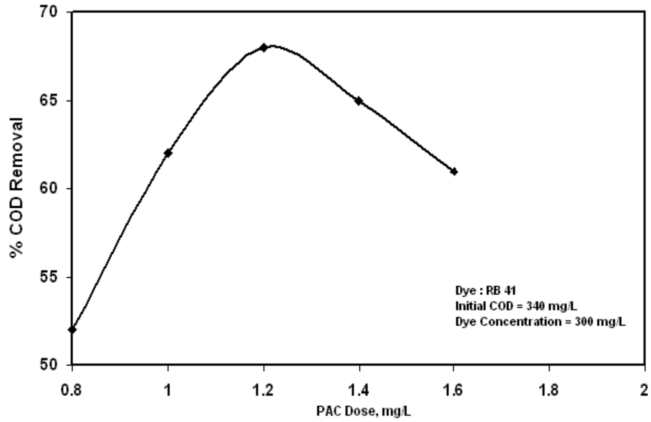

Fig . 1 Removal of COD by PAC at various doses

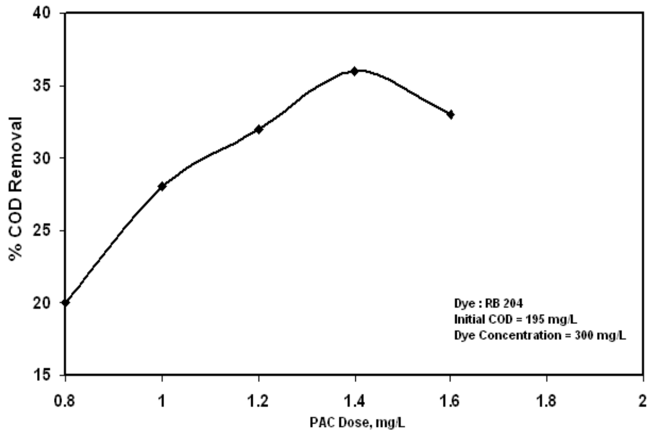

Fig .2 Removal of COD by PAC at various doses

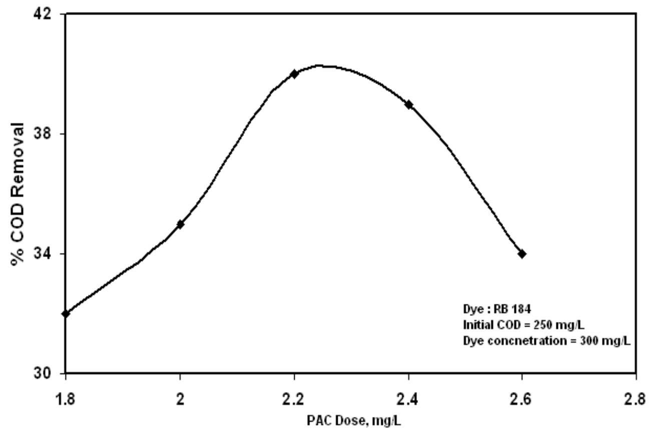

Fig .3 Removal of COD by PAC at various doses

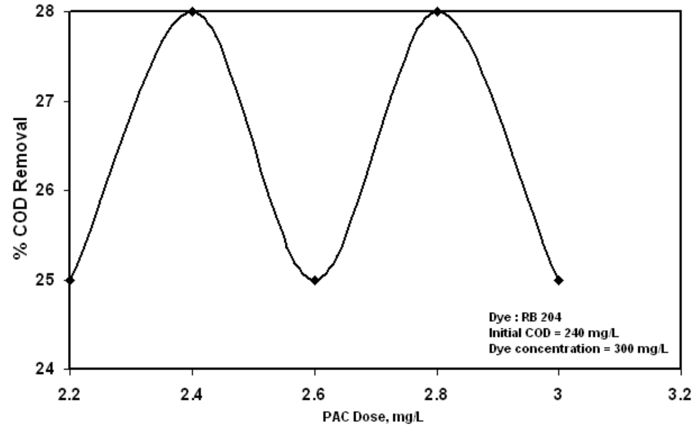

Fig .4 Removal of COD by PAC at various doses

highly soluble in water can not be easily flocculated by coagulants (Al degs, Y et al 2000). This is quite evident in floc formation in the present investigation.

Table - 2 Nature of Floc formations for different doses of PAC.

S.No.	Dye	Dose of PAC (g/L)	Nature flocs
1.	**RB 41**	**<0.4**	**No floc formation**
		0.4 – 0.8	**Slightly visible flocs with little settlement.**
		>2.0	**Highly turbid flocs with little settlement**
2.	**RB 184**	**< 1.0**	**No floc formation**
		1.2 – 1.6	**Slightly visible flocs with little settlement.**
		>3.0	**Highly turbid flocs with little settlement.**
3.	**RB 204**	**<0.4**	**No floc formation**
		0.4 – 0.8	**Slightly visible flocs with no settlement.**
		>2.0	**Highly turbid flocs with little settlement.**
4.	**RB 240**	**< 1.8**	**No floc formation**
		1.8 – 2.2	**Slightly visible flocs with no settlement.**
		> 3.4	**Highly turbid with no settlement.**

Table - 3 Optimum dose of PAC and percent removal of COD.

S.No.	Dye	Optimum dose mg. PAC/mg. COD removed	% COD removal
1.	RB 41	5.2	68
2.	RB 209	34.3	40
3.	RB 204	20.0	36
4.	RB 184	22.0	29

V. CONCLUSIONS:

1. Based on the present investigation, the following conclusions can be drawn:
2. RB 41 is only the dye responded for moderate removal COD. The other dyes responded poor removals of COD.
3. The order of demand of PAC for unit removal of COD is: RB 209 > RB 184 > RB 204 > RB 41.
4. The treated effluent with chemical coagulation by PAC needs further treatment to reduce COD.
5. The results of the present investigation is also an information to these dyeing units that it is waste of money to venture chemical coagulation when RB 184, RB 204 and RB 240 being present in dye waste water.

VI. REFERENCE:

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A New Horizon in the Field Of Maintenance and Effective Upkeepment of Bituminous Road Surface

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GJRE Classification (FOR)
090503, 090506, 090403 & 090507

Abstract: **To prevent natural wear and tear, bituminous surfacing is done on the flexible pavements. But in India in particular, various reports indicate that during monsoon seasons, the damages caused in case of bituminous surfacing is quite frequent. Due to this condition, a material obtained from tire dust derived from waste tyres has been started is to be used as mixture with bitumen so as to improve its penetration and other properties. This paper dicusses the**

I. INTRODUCTION

It is well recognized that transport infrastructure plays a key role in economic growth and development of the country. In India, road transport carries about 90 percent of the passenger traffic and 70 percent of freight transport. The growth of passenger and freight traffic by road is 8 to 10 percent per annum, while the same in rail is 4.5 percent. Due to rapid urbanization and mass industrial development, there has been a tremendous increase in traffic intensity and axial loads.

In India of flexible pavements constitute over 95 percent of total road network .The maintenance of this huge network is not an easy task. It requires technical skills apart from huge financial resources to keep the Nation's biggest asset in serviceable condition. Due to shortage of funds alternative is to have a good maintenance system /procedures for effective upkeepment. The prevention is always better than cure. In India, it is estimated that over 22 lakh kilometers of road exits of which around 50 percent is surfaced. Among the surfaced roads, the bituminous pavements contribute to the maximum.

The damages of road pavements appear such regularly and frequenty during rains that bad road conditions have become synonymous with monsoon season. The cracks appearing in the top layer of a pavement which cause numerous problems such as discomfort to the users, reduction of safety due to the presence of potholes resulting from the ingress of water through the cracks, reduction of the sub-grade strength and scooping of soil particles through cracks. According to various performance reports, the useful life of bituminous overlays has declined from an average value 5 to 8 years in the past to 2 to 3 years in recent past.

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This needs review of whole process of construction maintenance of flexible pavement, like, its ingredients and procedure for construction .In order to make construction procedure effective, the modernization of plants, equipments and machinery is the requirement of time. The main and most important ingredient, which imparts the flexibility, resistance to deformation, resistance to weathering, stability etc, is the binder.

In view of above, it is important that properties of binder are improved by addition of polymers or other suitable additions so as to gear up its performance for road construction. Apart from need of modernization of construction procedure, the modified /improved basic ingredients for bituminous works are also required.

II. OBJECT OF THE STUDY

The basic ingredients for bituminous work are bitumen binder, aggregates and lime. The main and most important ingredient, which imparts the flexibility, resistance to deformation, resistance to weathering stability, etc, is the binder. Due to inherent characteristic of mineral aggregates and also the Bituminous binders there is always a tendency of diminishing strength of bond between bituminous coating and aggregate particle where of mixed material remains in contact with water for a long time.

To use the paving grade, bitumen because of the drawbacks of 80/100 or 60/70 grade in bituminous susceptibility to temperature variations, tendency to crack, lesser effective service life etc, caused Engineers and Scientist to look forward for alternative methods of road construction.

Modification of binder in place of virgin grade of binder has become a necessity and voluntary phenomenon in the developed countries. The purpose is to achieve a high performance binder with improved properties, particularly at extremes of temperature. For the present study, tire dust derived from waste tyres, has been used for modification of bitumen. Different forms of rubber have been tested for road rubberisation. It has high gas temperature susceptibility, low temperature cracking etc, to a great extent. But unfortunately no extensive studies are reported to have been made on road rubberisation in our country.

Laboratory studies and field experiments conducted in India and abroad have shown that the addition of rubber in any form can improve the properties of both bitumen and tar. A brief review of the previous investigation and their findings are discussed in this chapter.

The objectives of the present study are:

1. To study the effect of tyre dust on the properties of penetration grade bitumen (80/100) commonly used for major road construction.
2. To study the effect of tyre dust in various concentrations, mixing with bitumen to get optimum blends.
3. Sealing of cracks & patch repair of distressed pavements using Rubber bitumen blends.

III. MATERIAL USED

The basic ingredients for bituminous work are bitumen binder, aggregates and filler material. Using rubber based compounds the refinery bitumen modified at the rate of 1 to 15 percent by weight of bitumen mixed by mechanical stirrer at a temperature of 155^0 c to 170^0 c.

A. Aggregates: -

The quantities of the aggregate required for different bituminous treatments can be obtained from the standard /specifications of MORT & H. The aggregate should be tough, durable and sound as per the required specifications. Granite stone chips available in the chandil quarry in Jharkhand, India where used as course aggregates in this investigation. Sand was collected from the bed of River Subarnarekha flowing besides Gopiballavepur, West Bengal, India. The aggregate gradation recommended by ministry of Road Transport & Highways.

Coarse aggregate: - Aggregate fraction retained on IS Sieve 2.36mm was used as coarse aggregate.

Fine aggregate: - Quarry dust passing IS Sieve 2.36mm and retained on IS Sieve 75 micron was used as the fine aggregate. The properties of aggregates and filler are presented in Table1.

B. Binder: -

The binder shall be bitumen is a viscous liquid, semi solid or solid material, colour varying from black to dark brown, having adhesive properties, consisting essentially or hydrocarbons derived from distillation of petroleum crude or natural asphalt and soluble in carbon disulphide. The bituminous binder should posses the following qualities

Adequate viscosity at the time of mixing & compaction.

Not highly temperature susceptible

Should not strip off from aggregate in presence of water.

The selection of binder depends upon the nature of traffic and climatic condition. 80/100-penetration grade bitumen conforming to IS: 73-1992 collected from the Haldia refinery was used.

Table1. Physical Properties of Filler and Aggreates Used

Material	Parameter	Value
Coarse aggregate	Specific gravity	2.685
	Water absorption	0.93%
	Abrasion value @ Los Angles	14.2%
	Aggregate Impact value	17.5%
Fine aggregate	Specific gravity	2.65
	Water absorption	0.75%
Quarry dust	Specific gravity	2.63

C. Crumb Rubber (C.R)

Crumb Rubber shall be a powder obtained from retarding or reclaiming of old truck tyres. It is collected from local tyre retarding shop in Midnapur, West Bengal. The chemical properties of rubber powder is given in Table-2

Table2
Chemical Properties Of Crumb Rubber

Properties	Value
Ash content	3.0% to 4.0%
Carbon black	32.0% to 36.5%
Acetone content	10.5% to 11.5%
Rubber hydrocarbon	48.5% to 51.0%

IV. PREPARATION OF RUBBER BITUMEN BLENDS:

Required quantity of rubber powder of particle sizes viz, 0.15mm to 0.3mm, 0.3mm to 0.6mm and 0.6mm to 1.18mm shall be soaked separately with 80/100bitumen in the proportion of 1percent, 5 percent, 8 percent, 10 percent and 15 percent by weight of bitumen in separate contains for 24 hours. The soaked rubber shall be diluted to desired concentration by adding neat hot bitumen and stirred by a mechanical stirrer at 800-1000 rpm for about an hour at 150^0C – 170^0 C. Small quantity of limestone dust of approved quality shall be mixed at the rate of 3 kg/100kg of blends. It shall be stirred for about 10 minute for homogeneous mixing of blend. The bitumen tyre dust blends appeared like a thick paste with very high viscosity.

V. Tests conducted and analysis:

The penetration softening point, ductility and specific gravity tests were carried out according to the relevant IS code for the test. The results were shown in Table 3 and Table 4.

A. *Specific gravity and ductility*:

The ductility values got reduced drastically for blends with increasing particle size of tyre dust, from a value of 65cms for plain bitumen to 17cms for the blend of tyre dust with fine particle size. The specific gravity values got increased with increasing concentration of tyre dust for the same particle size.

Table-4
Physical Properties Of 80/100 Bitumen With Tyre Dust Particle Size 0.3mm– 0.15mm For Varying Concentration

Properties	80/100 Grade Bitumen	Bitumen with rubber content (%)				
		1.0	5.0	8.0	10.0	15.0
Penetration value @25^0C, 5S, 100gm	88	82	74	71	70	66
Softening point (^{o}C) @ring ball test	42	50	56	58	62	68
Ductility [cms] @27^0c, 5cm/min	65	41	38	36	35	30
Specific gravity	1.015	1.016	1.020	1.021	1.024	1.029

Table-3 Physical Properties Of 80/100 Bitumen With 8.0 Percent Tyre Dust For Different Particle Size

Properties	80/100 Grade Bitumen	Tyre dust with particle size		
		0.3mm - 0.15mm	0.6mm-0.3mm	1.18mm-0.6mm
Penetration value @25^0C, 5S, 100gm.	88	71	62	55
Softening point (^{o}C) @ring ball test.	42	58	54	52
Ductility [cms] @27^0c, 5cm/min.	65	36	27	17
Specific gravity	1.015	1.021	1.025	1.028

B. *Penetrations and Softening Point*:

The penetration values of binder modified with tyre dust blends are reduced compared to the original penetration value for plain bitumen. The reduction in penetration is more with increasing concentration of rubber powder. The softening point values are decreased with increasing particle size of tyre dust and increasing concentration of tyre dust in bitumen. The variation of penetration value and softening point with tyre dust content is shown in Fig.1& Fig.2 respectively.

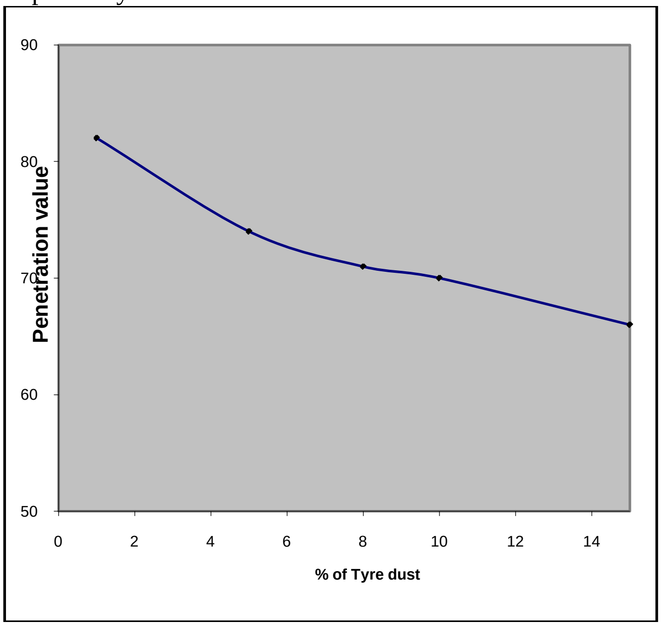

Fig-1 Penetration value Vs Percentage of Tyre dust content in 80/100 bitumen.

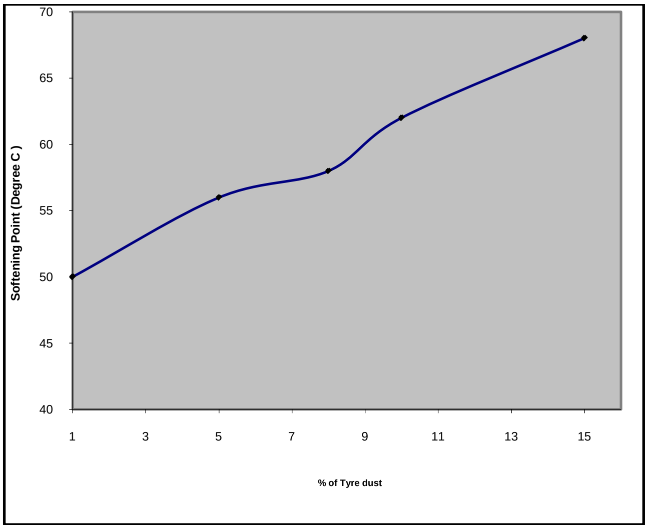

Fig-2 Softening point Vs Percentage of tyre dust content in 80/100 bitumen

It is obvious from the test results that the use of tyre dust with bitumen imparts higher softening point and elastic recovery and low penetration as compared to neat pavement grade bitumen. The higher value of softening point, imparts low susceptibility to temperature and more strength to bear more loads at high temperature

VI. Application

The details of application of rubber-bitumen stress absorbing membrane are as underneath.

A. Sealing of cracks using Rubber-Bitumen Blends.

Surface shall be cleared of all loose dust using wire brushes, coir brushes and/or compressed air. Rubber bitumen blends shall be applied. The quantity of rubber bitumen blends (8.0 percentage by weight of tyre dust with particle size of range 0.3mm to 0.15mm) depends upon type of distress and the situation of existing distress condition will govern the choice of treatement.

- Capillary cracks, map cracks ,reveling and 9-11 Kg/10 sqm
- Fatigue cracks up to 3 mm
- Cracks 3 mm to 6 mm 11-13 Kg/10 sqm .
- Cracks above 6 mm width 13-15 Kg/ 10 sqm .

The Treatment essentially consists of a thin layer of rubberized bitumen and covering the same while it is still hot, with fine stone chips(5.6mm size) and compacting with road roller immediately . This treatment forms a micro surfacing with perfect water proofing properties. The cracked, reveled and porous textured portions of pavement surface are clearly demarcated and given the treatment.

B. Patch repair of distressed pavements using Rubber-Bitumen Blends.

Potholes should be cut on their sides vertically to the affected depth in regular shape. All potholes shall be repaired on day earlier by strong cable mixed. The rubberized bitumen layer shall be repaired immediately be covered by specific quantity of approved quality of aggregate. Aggregate may be slightly hot, either heated or sunlight heated. 6-8 tones roller as suggested for surface dressing shall roll surface. The roller wheels shall be kept wet to avoid pick up of the mix. The temperature of mixing and rolling shall be slightly higher than conventional bituminous mixes. The exact temperature depends upon the tyre and amount of modifier used and the viscosity of rubberized bitumen

VII. Conclusion

The use of rubberized bitumen improves the vital properties of the bitumen, which in turn improves the property of bituminous mix. Although, the cost of blends is more initially and increase in the cost is of the order of 2 to 5 percent only but the use of rubberized bitumen is economical in terms of life-cycle cost. Based on the observation made from the various experimental investigations conducted the following conclusion have been drawn.

1) Due to the addition of tyre dust the bitumen is hardened. The penetration values are decreased and the softening point values are increased.
2) For the optimum blends of rubber additives the maximum stability value was obtained for 8 percent tyre dust with particle size of range between 0.3mm to 0.15mm.
3) The riding quality prisumes to be very good.
4) The rubberized strength stretch showed improved resistance to rutting, moisture damage and age hardening as compared to ordinary bitumen stretches.
5) The rubberized bitumen possesses higher resistance to deformation at high pavement temperature.
6) The rubberized bitumen creates better adhesion between aggregates and binder.
7) Filling the cracks with bitumen modified with crumb rubber has been found to be the most effective among the treatments tried.

Although, the use of rubberized bitumen is justified but there some problems with regards to availability and quality of rubberized bitumen. The Indian road congress published tentative guidelines for use of crumb rubber modified bitumen in road construction (IRC:SP:53) but there are no clear guidelines about the shelf life of modified bitumen and the bitumen modifier. Most of the bitumen modifiers are manufactured by the private parties, have there is always chance for heterogeneous mixing of modifier with neat bitumen. In view of the above , it is recommended that the rubberized bitumen must be prepared in refineries commercial basis. The quantity and quality of material, manpower and equipment to be used should be assessed to make full utilization of the same.

VIII. ACKNOWLEDGEMENTS

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Tested Performance Parameters of Diesel Fuel and Transesterified Sheanut Oil Blends in Compression Ignition Engine

GJRE Classification (FOR)
090201,090202,090403 & 090406

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***Abstract*-The rapidly depleting conventional crude oil resources and growing environmental concerns has significantly promoted research interest in renewable fuel for internal combustion engines. To this end, this paper presents the results of engine performance characteristics for various blends of diesel fuel and transesterified sheanut oil in a compression ignition engine. In this case, a test rig of 2.43 kW, 165 F single cylinder -four stroke variable speed direct injection engine, and incorporated with a 1.25kVA Honda E 1500 A.C dynamometer manufactured by Ningbo Tri-circle Power Machinery Company, China and Honda Company, Japan, was used to conduct the engine performance tests on samples of fossil diesel fuel (DF), and diesel fuel containing 5%, 10%, 15%, and 20% by volume of sheanut oil methyl ester (i.e. B5, B10, B15, and B20 DF-SHOME blends) respectively. At maximum engine speed the result show that B5 and B15 DF-SHOME fuel blends exhibited slightly higher brake power, brake mean effective pressure, brake thermal efficiency and heat loss in exhaust and lower specific fuel consumption than B10, and B20 fuel blends and diesel fuel benchmark respectively. This study has shown that the use of transesterified sheanut oil as a biodiesel or diesel fuel conserver in compression ignition engines could possibly ameliorate Nigeria's lingering energy crises, and also assist in the conservation of its crude oil reserves.**

Keywords: Transesterified sheanut oil; diesel fuel conserver; brake mean effective pressure; brake power; brake thermal efficiency; energy crises; specific fuel consumption.

I. Introduction

Energy has a major impact on every aspect of our socio-economic life. However, the rapidly growing global and domestic demand for petroleum products, and the consequent depletion of the crude oil reserves, adverse environmental concerns and unstable nature of the international oil market the need to explore alternative fuel options from locally available renewable energy resources has become imperative (Peterson, et. al 1990; Al Wydyan and Al Shyouk, 2002; Bernardo et al., 2003; Wirawan et al., 2008). For this reason, a deliberate diversification to achieve a wider energy supply mix will no doubt ensure greater energy security for Nigeria (ECN, 2003). Consequently, the search for an alternative fuel, which promises a harmonious relationship with sustainable development, energy conservation and efficiency, and environmental preservation, is being encouraged (Bhattacharya et. al. 2006).

Nigeria is no doubt endowed with a variety of edible and non- edible seed crops with even more diverse species found in the nation's forest reserve. The sheanut tree (*Vitellaria paradoxa* formerly called *Butryospernum paradoxum*) is an important oil bearing plant. It is known for its nutritional, industrial and pharmaceutical uses (Alonge and Olaniyan, 2007). The tree is extensively found more in the guinea savanna and less abundantly in the sudan savanna, across 19 countries of the African continent, and these include; Benin, Ghana, Chad, Burkina Faso, Cameron, Central Africa Republic, Ethiopia, Guinea Bissau, Cote d Ivories, Mali, Niger, Senegal, Sierra Leone, Sudan, Togo, Uganda, Zaire (now Democratic Republic of Congo), Guinea and Nigeria (Fobil et al., 2008). Furthermore, the result of a study on the potential use of sheanut oil as an alternative diesel fuel revealed that the oil possess favorable fuel properties but its high viscosity profile, pour point and lower heating value were found to impede optimal engine performance (Yusuf, 2000). In other related studies, seed oils in their unmodified forms exhibited some engine durability problems such as; power loss, carbon build up in combustion chamber, blockage of injector tips due to their comparatively higher viscosities, pour points and lower calorific values that are likely to cause engine failure in the long run (Reid et al. 1982, Tahir et al. 1982, Bacon et al. 1981, Schoedder, 1981, Yarbrough et al. 1981).

However, in the bid to surmount these challenges and also ensure the usability of sheanut oil as a viable alternative to diesel fuel, the oil can be modified into biodiesel through transesterification. The transesterification process presents desirable biodiesel properties such as; low viscosity, low molecular weight, and high volatility to overcome the problem of incomplete combustion, poor atomization, ring sticking, sever engine deposits, and injector coking that are encountered when natural oils and fats are used (Sangha et. al., 2004; Alamu et.al. 2007).

In the light of the above, this work therefore seeks to evaluate the effect of diesel fuel-transesterified sheanut oil blends on the performance of a compression ignition engine. The result of this

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study is expected to contribute to the existing database of locally available alternative fuel resource with the potential of ameliorating Nigeria's energy insecurity.

II. MATERIALS AND METHODS.

***Sample collection*:**The tree of Vitteliaria paradoxa was identified within the environs of the Federal Polytechnic, Bauchi by a botanist. The harvested seeds were collected and sun dried for seven days and their oil was extracted mechanically with a manual press. The oil sample was collected in plastic containers and stored at room temperature of 33oC for analysis.

***Extraction procedure*:** Depulped sheanut kernel were dried and baked to prevent the growth of fungi (e.g Aspergillus sp.). The baking process is controlled in a chamber between the temperatures of 85oC-100oC to prevent the charring of the kernel, a condition that reduces the fat content (Fobil et al., 2009). The baked kernel were then crushed and grounded in large wooden mortars. Subsequently, the powdered kernel was mixed with water and boiled. The resulting mixture was stirred continuously into a paste. The paste is allowed with to settle with oil floating on top of the supernatant and eventually scooped-off, decanted, cooled and preserved in an air-tight plastic container.

***Physico-chemical characterization*:**The physical and chemical properties of sheanut oil including the specific gravity, saponification values, peroxide values, iodine values, free fatty acid and PH values respectively were determined according to standard procedure (AOAC, 1980; Pearson, 1981, Pa Qurt, 1979).

***Fatty acid determination*:**The fatty acid of the oil sample was determined by the method described by Atasie et al. (2009). In this case, about 2 grams of the oil sample was weighed, in a small beaker and dissolved in 50ml of chloroform, transferred into a hundred volumetric flasks and diluted to the mark with chloroform. 1 mL of the unknown sample was transferred into a 10 ml screw top culture tube with a Teflon liner. Exactly, 1.00mL of a standard solution of 0.814 mg/mL pentadecanoic acid was then added. The glycerides in the oil sample was esterified as well as the pentadecanoic acid standard, the efficiency for the esterification of the standards is the same as that of the glycerides, the response of the detector to each of the fatty acid methyl ester with the internal standard was the same, with these we were able to determine the amount of each ester in the fat by comparing the integrated areas with the known concentration of the standard. Most of the chloroform was evaporated under a stream of nitrogen until-100µl of the solution remained. 1 ml of inter esterification reagent (25 vol % of a 12% BF3 methanol solution, 20 vol % benzene and 55 vol % methanol) was added. The tube was flushed with nitrogen, sealed and heated in a 100oC water bath for 30 minutes – after which the methyl esters was extracted with hexane and water, the final mixture of the reagent, hexane and water were in the ratio 1:1:1 (adding 1mL each of hexane and water to the reaction mixture). The mixture was shaken thoroughly for 2 minutes. A stable emulsion was formed which was broken by centrifugation. Half of the top hexane phase was transferred into a small text tube for injection.

***Transesterification of sheanut* oil:**1.0g of KOH was weighed on a digital beam balance and dissolved in a beaker containing 100ml of distilled water (H2O) to give 1% of KOH solution.282g of sheanut oil was weighed and preheated to a temperature of 45oC to 50oC. Furthermore 102.2g of methanol was also weighed and poured into the preheated sheanut oil in a plastic container to maintain an alcohol to oil molar ratio of 6:1.1.0g of KOH was weighed on a digital beam balance and dissolved in a beaker containing 100ml of distilled water (H2O) to give 1% of KOH solution.282g of sheanut oil was weighed and preheated to a temperature of 45oC to 50oC. Furthermore 102.2g of methanol was also weighed and poured into the preheated sheanut oil in a plastic container to maintain an alcohol to oil molar ratio of 6:1.

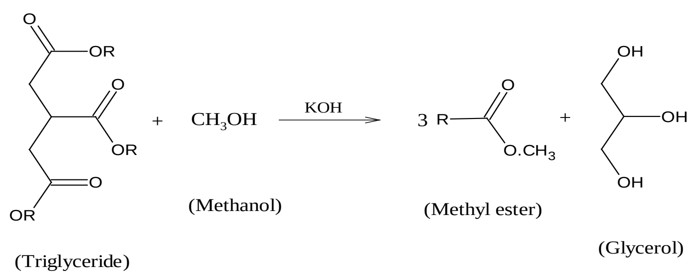

Figure 1.Methanolysis of triglyceride.

***Blending of sheanut oil with diesel fuel*:** 25 ml of SHOME and 475ml of diesel fuel (DF) were measured with a 500ml measuring cylinder and poured into a 500 ml beaker and stirred thoroughly to produce B5 DF-SHOME blended fuel samples. The mixture was allowed to settle for 4-6 hours for miscibility and homogenous consistency. The procedure was repeated for B10, B15 and B20 DF-SHOME blended fuel samples respectively.

Determination of fuel properties: Physical properties of SHOME and DF were conducted in accordance with standardized ASTM test procedures and these include; ASTM D97-93, ASTM D2015-85, ASTM D 2500-91, ASTM D 97-93, ASTM D 93-94, ASTM D D613, ASTM D

445 for density , higher heating value, cloud point, pour point, flash point, cetane number and kinematic viscosity respectively(ASTM, 1993).

Engine Performance Test: A 3.26hp single cylinder four stroke 165F compression ignition engines incorporated with a 1.25kVA Honda E 1500 A.C dynamometer with technical specification presented in Table 3 and 4 respectively was used to conduct the performance test. The engine performance characteristics was monitored within the speed range of 1400rpm and 2600rpm, and varied incrementally by 400 rpm after every interval of two hours. A control test was carried out on Diesel fuel for an experimental period of 8 hours. Similar test procedure was repeated for B5, B10, B15 and B20 DF-SHOME fuel samples. The brake power, specific fuel consumption, and brake thermal efficiency, heat loss in exhaust and generator efficiency were monitored respectively.

Table 1. Technical specifications of engine test rig.

Model	**165 F**
Type	Horizontal single cylinder four stroke, air-cooled
Bore * Stroke	65 mm x 70 mm
Rated output	2.43 kW (3.26 h.p)
Rated speed	2600
S.F.C at rated output	<284.2 g/kW-hr
Method of cooling	Air cooling by blower
Lubrication method	Centrifugal lubrication, combined oil mist and splash
Starting method	Manual cranking
Compression ratio	20.5:1
Manufacturer	Ningbo Tri-circle Power Machinery Co. Ltd. China

Table 2. Dynamometric specifications.

Type	**HONDA Model E 1500**
Maximum operating capacity A.C	220V, 50Hz, Single phase
Maximum operating capacity D.C	12V, 8.3A
Maximum speed	4000rpm
Torque arm radius	130mm
Manufacturer	Honda motor, Tokyo, Japan

III. RESULTS AND DISCUSSION.

Table 3 shows the physico- chemical properties of sheanut oil. The relative density of sheanut oil (0.98). The saponification value of 195 mg/KOH/g explains the oil high tendency to soap formation. According to Halling (1989), the formation of soapy film provides adequate boundary lubrication and reduces engine wear. The peroxide value of 0.28 meq/kg explains that sheanut oil can resist lipolytic hydrolysis and oxidative deterioration. Iodine value of 87 g/100g shows the high degree of oil unsaturation, and is classified as a semi drying oil (90-130g/100g) as expressed by Remington and Wood (1918). Furthermore, the free fatty acid value of sheanut oil of 0.23 mgKOH/g indicates the percentage of fatty acid present in the oil that predisposes the oil to undergo oxidation. It is pertinent to mention, that poor oxidation stability can cause fuel thickening, formation of gums and sediments, which in turn can cause filter clogging and injector fouling. The oil's PH value of 4.22 indicates the degree of the oil acidity. The fatty acid profile of sheanut oil in table 4 show the composition of palmitic acid as 4,00%, stearic acid as 8.0%, oleic acid as 73.11%, linoleic as 13.9%, and linolenic acid as 0.4% respectively. The fairly high percentage of fully saturated fatty acid, and polyunsaturated linoleic and linolenic acids predisposes the oil sample to oxidative instability and shorter shelf life (Asadauskas and Perez, 1997). It could also be seen from table 5 that the specific gravity of SHOME oil sample is slightly heavier than conventional diesel fuel, In addition, the viscosity of the fatty acid methyl ester is also higher in comparison to diesel fuel. It was also noted that beside lubrication of fuel injection system components, fuel viscosity controls the characteristics of the injection from the diesel injector such as; droplet size and spray characteristics (Lele, 2004). Furthermore, the heating value of SHOME is observed to be higher than diesel fuel. The lower heating values of SHOME oil sample suggest a significant effect of oil density on calorific value (Atasie *et* *al.*, 2009; Ams oil, 2005).The flash and pour points of the SHOME oil sample are also higher than diesel fuel. The flash point of biodiesel blend is dependent on the flash point of the base diesel fuel used, and increase with percentage of the biodiesel in the blend. Thus, in storage and usage biodiesel is less flammable and safer than conventional diesel (Lele, 2004). However, the high pour point of SHOME oil sample constrains oil performance at low temperature conditions (Gawrilow, 2003). Furthermore, SHOME oil sample exhibited higher cetane number than conventional diesel fuel and these results in higher combustion efficiency and smoother combustion (Lele, 2004).

The engine performance results illustrated in figures 1-6 shows that the brake power, b.m.e.p, brake thermal efficiency, Air fuel ratio and heat loss in exhaust for tested fuel sample increase with engine speed, while specific fuel combustion and the generator efficiency decrease with engine speed and reach a minimum level at 2600rpm. Table 7 also show that (except for B5 SHOME-Diesel blend that is 4.0% less than diesel fuel) the exhaust temperature for B15 and B20 SHOME-Diesel blend are 8.8% and 16.0% higher than diesel fuel. The increased exhaust gas temperature of the engine in this case may be caused by the rise in peak cylinder pressure resulting in higher peak combustion temperature as reported by Ecklud, (1984). In addition, a relationship could be established between exhaust temperature and brake power because a rise in combustion temperature brings about a commensurate increase in the pressure acting on the piston, to improve mechanical power output (TQ, 2000).

Table 3: Physico-chemical properties of sheanut oil

Appearance	Lightly yellow
Odour	Characteristically flat
Specific gravity	1.5
Saponification value	195
Peroxide value	0.28
Iodine value	87
Free fatty acid	0.23%
PH value	4.22

Table 4: Fatty acid composition (%) of sheanut oil.

Palmitic	4.00
Stearic	8.00
Oleic	73.11
Linoleic	13.9
Linolenic	0.4

Table 5: Fuel properties of SHOME and Diesel Fuel.

Characteristics	SHOME	DF
Specific Gravity at 35^{o}C	0.894	0.835
Viscosity m. Pa at 20^{o}C	4.2	1.6-5.5
Lower heating value Mj/kg	32-37	45.59
Flash Point (^{o}C)	162	65
Pour point	-7	-23
Cetane number	>51	48

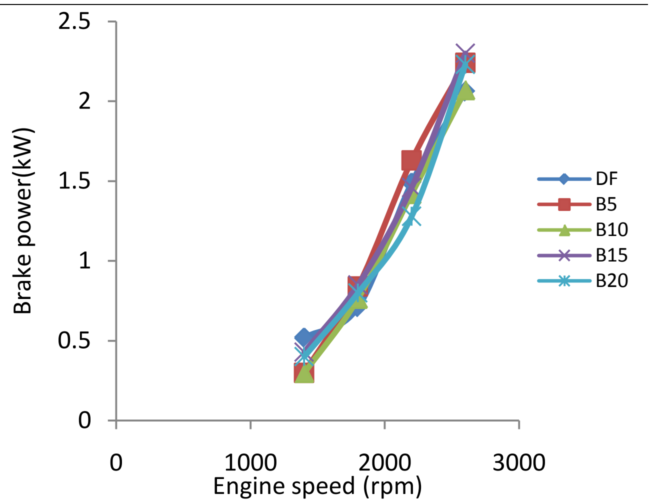

Figure 1: Brake power of DF and DF-SHOME fuel samples.

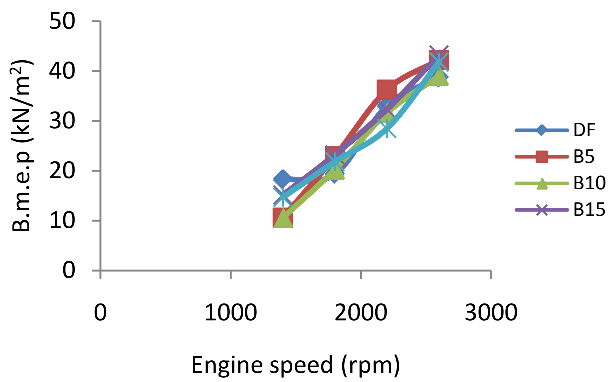

Figure 2: B.m.e.p of DF and DF-SHOME fuel samples

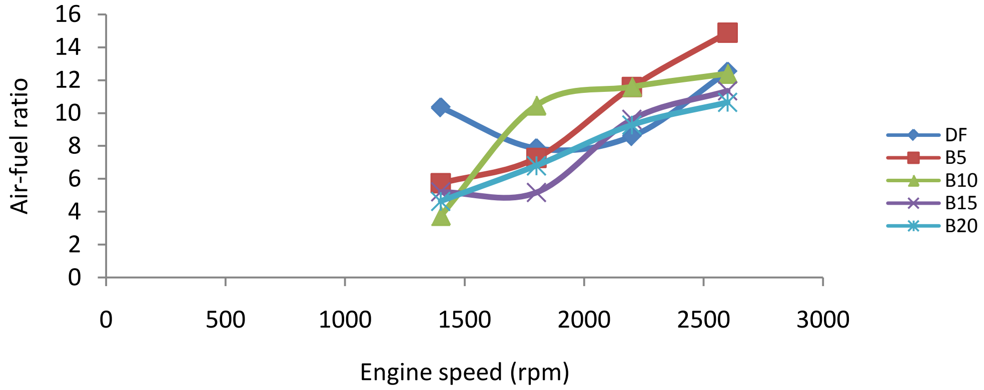

Figure 3: Air-fuel ratio of DF and DF-SHOME fuel samples

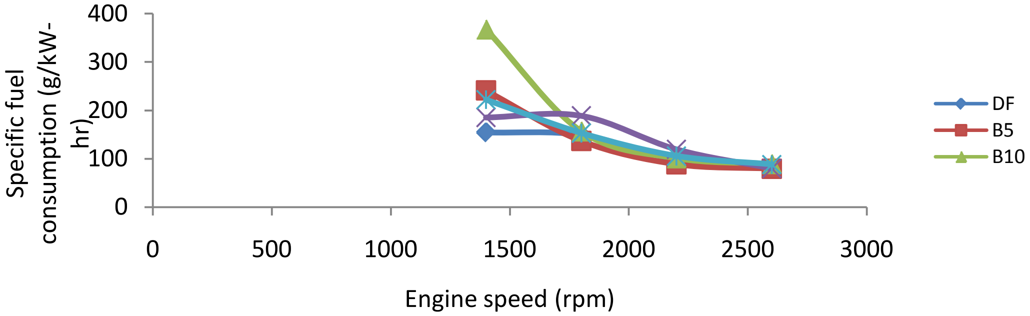

Figure 4: Specific fuel consumption of DF and DF-SHOME fuel samples.

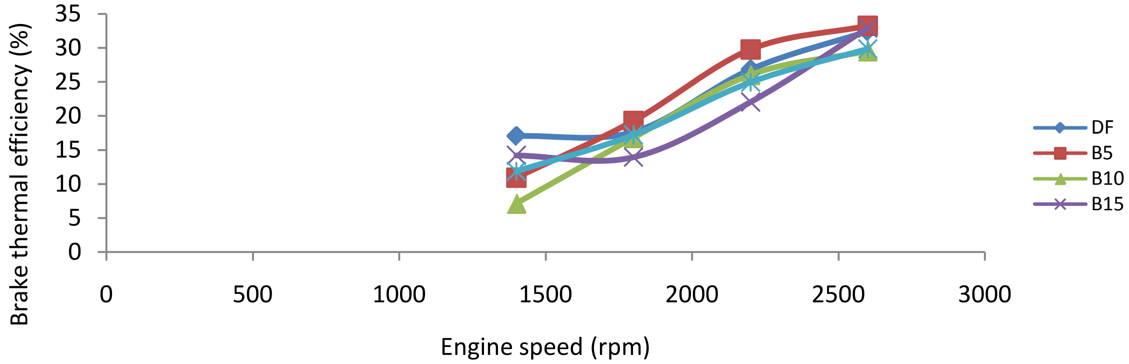

Figure 5: Brake thermal efficiency of DF and DF-SHOME fuel samples.

Table 6: Heating values and specific gravity of fuel samples

Properties	DF	DF-SHOME blends			
		B5	B10	B15	B20
Heating values Mj/kg	45.59	44.96	44.33	43.70	43.07
Specific gravity at 35^{o}C	0.835	0.849	0.864	0.879	0.894

Table 7: Performance characteristics of DF samples and DF-SHOME fuel blends at 2600 rev/min.

Performance Characteristics	Manufacturer's Specification	DF	DF-SHOME blends			
			B5	B10	B15	B20
Exhaust Temperature (^{O}C)	-	125	120	125	136	145
Torque (Nm)	-	8.93	9.01	9.01	9.01	8.87
Brake Power (kW)	2.43	2.06	2.24	2.07	2.30	2.23
Brake Mean Effective Pressure (kN/m2)	-	38.68	42.20	39.03	43.25	41.85
Specific Fuel Consumption (g/kW-h)	< 284.2	81.15	79.22	89.21	79.95	88.15
Brake. Thermal Efficiency (%)	-	32.43	33.22	29.50	32.91	29.85
Air Fuel Ratio.	-	12.51	14.89	12.30	11.35	10.64
Heat Loss in Exhaust (kJ)	-	202.99	228.14	223.43	229.52	211.32
Generator Efficiency ((%)	-	29.15	26.72	28.89	26.01	26.94

At maximum speed, B15, B5, B20 and B10 blends are 10.50%, 8.32%, 7.76% and 6.63% higher than Diesel fuel. However, the comparatively higher brake power generated by DF-SHOME fuel blends could be attributed to their higher calorific (heating) value as it combines with conventional diesel fuel to burn (refer to table 6). The brake mean effective pressure (i.e. the calculated mean pressure that would act upon observed power output, when no mechanical losses occur) behaves in a similar manner as the brake power. Masjuki and Maleque (1996) and Goering (1992) reported that, the average torque, brake power and brake mean effective pressure values of engines running on fatty acid methyl esters (i.e. biodiesel) blended oils are higher in comparison to diesel oil for the reason that biodiesel acts as fuel. In addition, Wirawan et.al. (2008) and Knothe et.al (2004) also reported that the higher engine power rating presented by biodiesel blends is no doubt affected by the lower viscosity profile of the tested pure biodiesel. This is because fuel viscosity also influences fuel injection and combustion. Hence, high fuel viscosity reduces fuel injection efficiency and atomisation, and could adversely affect fuel combustion leading to power losses in engine(s). Furthermore, it was also reported that as the concentration of biodiesel in fuel blends increases, the adsorption layer on metal surface in relative motion to one another (such as, injector system, pistons, rings and sleeves) become better lubricated and initiate a declination of frictional horse power to generate more power and brake mean effective pressure in the engine (Masjuki and Maleque, 1996; and Sabeena et.al., 2004). On the other hand, since fuel combustion could also influence engine power output, the presence of oxygen in biodiesel improves fuel combustion, brake power and b.m.e.p in engines.

The specific fuel consumption values in table 7 also reveal that B10 and B20 biodiesel blend are higher than diesel fuel benchmark by 9.04% and 7.94%, while, B15 ad B5 blends are 1.48% and 2.38% lower than diesel fuel respectively. The appreciably higher s.f.c of B10 and B20 Biodiesel could be explained in terms of higher specific gravity, higher viscosity and heating values of biodiesel and this indicates higher fuel consumption per unit of power produced due to low combustion efficiency (Bhattacharya.et al., 2006; Masjuki and Maleque, 1996; Sethi and Salariya, 2004). However, the fuel economy behaviour of B5 and B15 DF-SHOME fuel blends could be ascribed to their improved miscibility, better fuel atomisation characteristics and combustion. According to Wirawan et al, (2008), higher fuel viscosity reduces the quality of fuel atomisation, and could result in higher gas emission and fuel consumption. Except for B5 DF-SOME fuel blend, which demonstrated a16.01% higher Air fuel ratio (AFR) value than diesel fuel, B10, B15 and B20 DF-SHOME are 8.39%, 9.24% and 14.92% lower than diesel fuel benchmark respectively. The observation made from this finding is that all tested fuel samples reached maximum power output and torque at lower than the stoichiometric AFR values (i.e. 18-25) for compression ignition engines. In this case, maximum power output is achieved at richer mixture, therefore causing the engine to run at lower engine temperature and s.f.c. levels. According to Goering (1992), the stoichiometric AFR values of engines running on biodiesel are usually lower than diesel fuel because more oxygen presence is evident in biodiesel due to the methanolysis of sheanut oil, and it enabled SHOME blended fuel samples to burn much richer than diesel fuel.

The brake thermal efficiency of B5 and B15 DF-SHOME fuel blends are 2.38% and 1.46% higher than diesel fuel, while B10 and B20 blends are 7.95% and 9.04% lower than the diesel fuel benchmark. Plint and Partners (1984) observed that the fall in brake thermal efficiency and power output in some cases reveal that specific fuel consumption relates conversely with thermal efficiency. This however, emphasised the desirability of running engines at near their maximum power output to expect good return for the burnt fuel. The falling off in thermal efficiency are due to increase mechanical losses in engine relative to useful power output, throttling losses and deterioration in combustion efficiency, with increasing concentration of the biodiesel in the DF-SHOME fuel mixture (Pathak, 2004; Singh et. al 2007, and Plint and Partners, 1984). It could also be seen from table 7 that; B20, B15 and B10 DF-SHOME blends show evidence of higher heat losses in engines than diesel fuel by 19.23%, 11.56%, 11.02% and 9.15% respectively. The higher heat losses recorded could be explained in terms of lower calorific (heating) valve, increase in fuel density, the difference between the exhaust and ambient temperatures and the size of the engine. The temperature difference existing between the fuel blends and diesel fuel benchmark in table also presented a proportional increase in the heat carried away by the exhaust. However, for heat unaccounted for by losses is partly a function of the engine size. Hence for smaller engines, considerable conductive and radiative heat losses are usually caused by inefficient combustion (Plint and Partners, 1984).

The generator efficiency (i.e. the ratio of the electrical power output of the machine to the mechanical power input) of B20, B5, B10 and B15 fuel samples are lower in comparison to diesel fuel by 7.59%, 8.33%, 9.05% and 10.78% correspondingly. The decreasing generator efficiency of DF-SHOME fuel blended samples could be attributed to reduced heating value as shown in table 6, lower combustion temperature and flame velocity of blended fuel air mixture (Singh et al. 2007; Asokan, 1990, Bhattacharya et al., 2001 and Uma et al. 2004). However, since the fuel blend exhibit higher brake power and brake mean effective pressure, it implies that the combustion temperature and efficiency of biodiesel blends are significantly higher and therefore their reduced heating value is responsible for the progressive drop in engine generator efficiency with the corresponding increase of biodiesel concentration in the fuel mixture.

IV. Conclusion.

The results of the study on the performance characteristics of diesel fuel -transesterified sheanut oil blends in compression ignition engine are presented as follows:

1. Brake power, b.m.e.p., brake thermal efficiency, air fuel ratio and heat loss in exhaust increase with engine speed.
2. Conversely, specific fuel consumption and generator efficiency decrease with engine speed respectively.
3. DF-SHOME fuel blend generated slightly higher brake power, b.m.e.p., and brake thermal efficiency and higher heat losses in exhaust than diesel fuel.
4. The generator efficiencies of DF-SHOME blended fuel samples are lower than diesel fuel samples.
5. iv. B5 and B15 DF-SHOME blended fuel samples exhibited higher brake power, b.m.e.p, fairly higher heat losses in exhaust, and present lower fuel consumption than other tested fuel samples.

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Stress Management among Artisans in Construction Industry in Nigeria

GJRE Classification (FOR) 090702,150308,090702& 091402

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***Abstract*-It is rather important for artisans that are directly involved in the handling and usage of materials that constitute about 60% of the cost of building projects to be emotionally stable so as to perform optimally. Hence, this study assesses stress management among artisans in construction industry by determining its causes, effects and the possible ways to effectively manage it. The result of the study shows that most artisans experienced much stress at their work place than at home, and the stress had negative effects on their productivity at work, and at the same time caused medical problems in their body systems. The study also shows that aerobic, bio-feedback, relaxation, laughter and social support are the commonest ways artisans use to manage stress while their common stressors are drinking, quarrelling, clubbing, flirting and smoking. The study concludes that every construction firm should make provision for the management of stress of artisans through proactive strategy, non-specialist and specialist assistance measures, restructuring of social-physical environment, time-off and social activities measures while artisans should adhere to their chosen ways of managing stress as these would help to achieve optimal performance at work.**

Keywords-Stress, Stressors, Construction Industry, Performance, Manageability.

I. Introduction

THe construction industry is important in any nation's economy as it contributes to the process of development. It equally has many features that set it apart from other industries and which accentuate the need for professional engagement. The team for each project is assembled from a disparate collection of professionals, subcontractors, craftsmen, artisans, labourers and suppliers within and outside the industry Bamisile (2004). Also, there is sufficient evidence to show that a growing number of people are involved in the activities of the industry. Construction relates to the erection or assembly of large structures. It is in common usage, most frequently applied to such major works as buildings, ships, aircrafts and public works such as roads, dams and bridges. Construction process requires a lot of physical activities that are stressful to the participants in the industry. These physical activities are usually carried out by the artisans who occupy the lower part in the pyramid of personnel that contribute to the erection of the aforementioned structures.In view of the nature of production processes that take place in the industry,

construction work is an inherently dangerous occupation and highly prone to stressful environment Linda et. al. (2003). Researchers' interests in job-related stress have increased ramatically in recent years. This is because many

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d researchers believe that stress is becoming a major contributor to absenteeism, low employee morale, high accident and turnover rates, decreased productivity and increased company medical expenses (Whetten and Cameron1991; Steers, 1991). The term stress as it relates to human experiences has been in the scientific literature since 1930s. Today, the term is used in everyday vocabulary to capture a variety of human experiences that are disturbing in some manners. Stress according to Oxford Advanced Learners Dictionary (2006) has been defined as pressure or worry caused by the problem in somebody`s life. Stress is also a pressure put on something that can damage it or make it lose its shape. However, Health and Safety Executive (2001) equally defined occupational stress as adverse reaction by people to excessive pressure or other types of demand placed on them. It further affirmed that occupational stress or work place stress is that which is experienced as a direct result of a person`s occupation.

Various researchers equally made us understand that spending hours on work or on work related-issues will not only leave us to deal with work pressures, but also reduce the productivity level as well as increase proportion of our finance expended in keeping healthy. In fact, modern day living can be incredibly stressful and could impose high physical demand on our bodies as well as emotional costs on our lives Cohen (2002). Workplace stress is the harmful physical and emotional responses that can happen when there is a conflict between job demand on the employee and the control an employee has in meeting these demands. Stress reaction is seen as an individual response to a given stress; which can be behavioural, perceptual, physiological, emotional and cognitive, or signs and symptoms of illness or disorders such as headaches, alcohol abuse, obesity, cardiovascular disease and hypertension. Also, subjective sensations commonly experienced in conjunction with "feeling stressed" are headaches, shortness of breath, light-headache or dizziness, nausea, muscle tension, fatigue, gnawing in the gut, palpitations, loss of appetite or hunger and problems with sleep.

Behavioural manifestations of stress commonly reported are crying, smoking, excessive eating, drinking alcohol, fast talking and trembling. It is also common place for people to complain that stress negatively affects their functioning systems. It impairs concentration ability, problem-solving ability, decision-making ability and the ability to get work done. Many research studies have been focusing on the behaviour and performance of construction workers as building production managementmaintenance, management and estimating tasks are largely unstructured and relying on

]subjective judgment which the problem solving ability and performance of the construction workers could be affected by job stress. Stress can either be managed or reduced; this is because stress cannot totally be eliminated from the life of an adult human being.

Stress management therefore describes strategies of coping, recovering, reinterpreting, refraining and cognitive restructuring adopted by an individual who is under stress, making changes that can reduce stress or taking actions that can alter stress impacts. Gunning & Cooke (1986) found stress to be as much of a problem for the construction industry as almost any other profession, but noticed that individual in the industry felt that admitting to stress was a major sign of weakness. Artisan according to Oxford Learners Dictionary (2006) is a person who does skilled work and makes things with his hands. With this definition, artisans in the construction industry are carpenters, joiners, masons/bricklayers, electricians, plumbers, painters, plant operators, crane drivers, steel fixers and tile settlers. Activities in construction industry can be objectively harmful physically or mentally to the individuals involved in them, especially the artisans.

II. STAETEMENT OF PROBLEM

The most obvious stressors in the construction industry are physical; working with heavy equipments, noise, and vibration and chemical exposures e.g. asbestos, lead and epoxy resins. The effects or the problems this have on the personnel in the construction industry are the increase in heart rate and blood pressure, and changes in how well the skin conducts electrical impulses. Other types of job and organizational stressors, including a high level of job demands, too much work, insufficient social support, harassment and discrimination, the overall work environment and the composition of the crews have been shown to increase construction workers' risk to adverse physical and psychological outcomes (Helander,1991; Holmstrom et. al. 1992 and Vander-Molen et. al. 1998).

Furthermore, the entire class of physical problems known as psycho- physiological disorders often result from stress. These medical problems are caused by an interaction of psychological, emotional and physical difficulties. Stress contributes increased irritability, loss of self-esteem, loss of perspective when work invades family life, and feeling of helplessness and anger. It also results in excessive drinking, smoking and eating, all of which can lead to coronary heart disease which is responsible for the death of more than a quarter (27%) of men between the ages of 35 and 44 (Jeff Grout, 1994).

Artisans are found to be more susceptible to disease as their ability to fight off infection is lowered. In addition to major health difficulties, many of the minor aches and pains that men experience may be caused or worsened by stress. These include headaches, backaches, skin rashes, indigestion, fatigue and constipation. Stress among artisans in construction industry worth what to manage because cost of materials in construction works cover at least 60% of the cost of the whole project and the artisans are at the centre point of the success of any construction works since they are in charge of materials handling and performance of other operations on site. The artisans work with harmful building materials and are exposed to occupational stress. In respect of this, if they are not well catered for in the sense of managing the possible stresses, the output of the whole construction work would be affected negatively.

Equally, in view of the need to maximize productivity and profitability of construction industry and to enhance construction performance in a challenging environment, a stress management method is significant in providing valuable information on how to actively manage stress among construction industry participants, especially the artisans. Hence, this study aims at identifying stress being experienced by artisans in construction industry, identifying and evaluating the causes of the identified stresses, examining the effects of stress on the productivity of artisans and assessing the manageability of the stresses.

III. REVIEW OF STRESS AND CONSTRUCTION INDUSTRY

Health and Safety Executive (2001) defined stress as adverse reaction people have to excessive pressure or other types of demands placed on them. They also said, occupational stress or workplace stress is the stress experienced as a direct result of a person`s occupation. Lazarus and Folkman (1984) defined stress as that which a person appraises as harmful, threatening or challenging and also noted stress as a state produced by a change in the environment that is perceived as challenging threatening or damaging to the person`s dynamic balance or equilibrium. It leads to a real or perceived imbalance in the person`s ability to meet the demands of the new situation.

Stress in itself is not a bad thing. A certain amount is necessary to motivate someone, and without some pressures, life would become boring and without purpose. How man reacts to stress depends on whether one sees himself in control of a situation or overwhelmed by it (Cohen, 2002). Job stress has been defined as the harmful physical and emotional response that occurs when the requirements of the job do not match the capabilities, resources or need of the workers. Stress as an effective and unhealthy reaction to change and as a force which affects human beings physically, mentally, emotionally, socially and spiritually. Stress has always been an integral part of our daily life since prehistoric times. Stress was there when our predecessors were required to fight or flight for their survival. In modern times, stress plays an important role in how successful or unsuccessful we are in our productive work activity, and in general, in enjoying our live (Victor et al. 1991). Stress is not necessarily negative for our performance. Some levels of stress are desirable to generate enthusiasm, creativity, and productivity. However, excessive levels of stress could become counterproductive if the situation does not require this elevated level of stamina (Davidson, 1997).

The most obvious stressors in the construction industry are physical e.g. working with heavy equipments, noise, and vibration and chemical exposures e.g. asbestos, lead and epoxy resins. Indeed, the direct relationship between these types of stressors and illness and injuries on construction sites has been well documented Ringen et al. (1999). Other types of job and organizational stressors, including a high level of job demands, too much work, insufficient social support, harassment and discrimination, the overall work environment and the composition of the crews have been shown to increase construction workers' risk to adverse physical and psychological and potentially, injury outcomes Helander (1991); Holmstrom et al., (1992). Vander Molen et al., (1998) also identified other factors that cause stress in construction industry as deadlines getting shorter, working hour getting longer, short-term contract and increasing competition as well as stress caused by financial penalty clauses, confrontation within the industry and constant initiatives to improve productivity.

A close scrutiny of the identified stressors revealed that they could be meaningfully categorized according to their distinctive nature and characteristics Djebarni (1996). For example, some of the stressors are concerned with the time allowed for work execution, such as “quantitative work overload” and “tight-time frame for work”. In contrast, stressors such as “lack of career guidance” and poor communication with counter players” are typified by personal relationships among different parties of work. Also, stressors such as bureaucracy, inadequate room for innovation, unsatisfied salary and the policies of the organization play a significant role in their formation.

A worker that is exposed to stress is bound to exhibit certain symptoms. According to Cohen (2002), symptoms of stress are categorized into five classes as follows:-

1. ***Emotional*****:** anxiety, nervousness, depression, anger, irritability, guilt, moodiness, loss of enjoyment of life, loneliness, loss of humor, lack of confidence, isolation and job dissatisfaction.

2. ***Physical*****:** feeling restless, feeling uptight, jumpy, high blood pressure, back and neck muscle tension, lack of energy, dry mouth headaches, insomnia, dizziness, loss or increase in appetite and ringing in the ears.

3.,***Behavioural*****:** impatience, impulsiveness, hyperactivity, short temper, aggressiveness, alcohol abuse, use of drugs, avoiding difficult situations, loss of sex drive, and overworking.

4.***Mental*****:** frequent lapses of memory, constant negative thinking, being very critical of oneself, inability to make decisions, difficulty in getting things done, distorted ideas, very rigid attitudes and difficulty in concentration.

5.***Health:*** high blood pressure; higher than usual susceptibility to colds and flu, migraines, irritable bowel symptoms, ulcers, stomach disorders, heart attacks, angina, strokes, asthma and skin rashes.

Nevertheless, the most common symptoms are hair loss, insomnia, depression, irregular menstrual cycle, low libido, decrease or increase in appetite and high blood pressure. Some studies focused on the effects of stress on the performance of various professionals like physicians Chaplain (1995). Stress not only affects personal psychology, but it also influences the construction project, interpersonal relationships amongst project team members mostly the artisans, and finally the organizational relationship. Stress is considered as a major problem as it can lead to poor health and even injury. Stressors produce threats to well-being. Even, pleasant events like planning a party or beginning a sought after job results in greater detrimental consequences than positive ones.

Often, the most immediate to stress is a biological one. Exposure to stressors induces a rise in certain hormones secreted by the adrenal glands, an increase in rate of heart beat and blood pressure, and changes in how well the skin conducts electrical impulses. However, continued exposure to stress results in a decline in the bodies overall level of biological functioning due to the constant secretion of stress-related hormones. Overtime, stressful reactions can promote deterioration of body tissues such as blood vessel and the heart. Ultimately, we become more susceptible to diseases as our ability to fight off infection is lowered (Sapolsky, 1996).

Also, an entire class of physical problem, known as psycho-physiological disorders often result from stress. These medical problems are caused by interaction of psychological, emotional and physical difficulties. Among the common psycho-psychological disorders are headaches, skin problems and high blood pressure. Overtime, little stressors can add up and take a toll on our health and well-being. Hypertension (high blood pressure) rates are high among residents of urban ghettos, where the stresses that accompany poverty, unemployment and overcrowding are part of daily life for some people. A number of diseases and illness are associated with stress that workers are prone to. These diseases affect emotional stability at work and equally have a negative effect on level of productivity. Few of the identified diseases are as follows:-

Heart Disease*:* According to Friedman & Ulmer (1984), stress increases vulnerability to heart diseases. They also declared that men are more susceptible to heart disease because they do more stressful work than women. It is then obvious that artisans in the construction industry are all men and so they are susceptible to heart disease because of the nature of their work in the industry.

Arteriosclerosis: It is a kind of disease that makes reactive people to be vulnerable to high blood pressure, a risk factor for strokes and heart attacks. Further stress sometimes may trigger the altered heart rhythms than in those with weakened hearts can cause sudden death Kamarck and Jennings (1991). Research has revealed that those inclined to be hostile and cynical were five times more likely than their gentle trusting colleagues to die by middle age.

Depression: Women of age 67 or older with varying level of depression found significant differences in mortality due partly to increased heart diseases. In the year following a heart attack, depressed people have a quadrupled risk of further heart problems (Pratt, 1996). The depression that follows a spouse’s death similarly increases one’s risk of having a heart attack or stroke. Wilkinson and kawachi (1999) made it clear that depression substantially increases the risk of death, especially death by unnatural causes and cardiovascular diseases.

PSYCHO-PHYSIOLOGICAL ILLNESS: Such as hypertension and some headaches are stress related. A person under stress may retain excessive sodium and fluids which together with constriction of the arteries muscle walls and increase blood pressure Light et. al. (1983) ***AIDS:*** Researchers have found that stress and negative emotions do correlate with progression from HIV infection to AIDS and with the speed of decline in those infections.

CANCER: Although some researchers found no link between stress and cancer . But other investigators revealed that people experiencing work place stress had 5.5 times greater risk of colon cancer than those without stress.

WOUND**:** Studies of the effects of stress on wound healing and tissue repair have suggested that stress-induced neuroendocrine activation impairs healing and delays recovery.

IV. Research Methodology

The scope of this study was limited to construction companies in southwestern Nigeria by making Lagos and Ibadan as the study areas due to the fact that different types of construction activities are carried out there. Ajanlekoko (2001) confirmed that Lagos State accounted for 60% of construction projects in Nigeria and this would provide good opportunity to see large size of artisans and evaluate stress on their productivity levels. The population where the artisans to be examined in the course of this study were from the Federation of Building and Civil Engineering Contractors in Nigeria and who are mostly found working on construction sites in the country. The firms are supposed to have different artisans working on various trades and whom the data needed on stress can be gotten from. It was believed that construction activities in these locations would represent a good sample of construction activities in the country.

The sources of data employed during the course of this study were primary data and secondary data. The primary data were obtained through the use of structured questionnaires and interview that focused on issues relating to stress among artisans in Nigerian construction industry while the secondary data were obtained from the review of related textbooks, journals, articles, internet, records and any other publications on stress related issues in construction industry. A face-to-face interview method was used to complement questionnaires administered. The self–completion questionnaire method was adopted for this study where respondents answered questions by completing the questionnaires themselves and otherwise interpreted if they were illiterates. Simple words that would not pose ambiguity to the respondents explained in few paragraphs were used so as to get adequate contributions from them. The two methods of data collection; interview and questionnaires were structured to identify stressors, obtain basic biographic and behavioural information; the respondents were also asked about the common sources of stresses they experienced and the stress management strategies commonly used.

The method of analysis used in this study included both descriptive and inferential statistics. The descriptive statistics used included cross tabulation frequency counts and percentages method. Tabulation is the arrangement of data involved in tabular form. It forms the basis of reducing or simplifying the details in a mass of data into such a form that the main features would be brought out to make the assembled data easily understood. It equally helps to condense the data and to ease comparison of data. The inferential statistics used included the use of likert scale for the qualitative assessment of the data gotten from the questionnaires.

V. Results and Discussions

This section focuses on the analysis of the data collected and the presentation of the results. It also explains the method of measurement used, method of coding and the type of analysis carried out. From these analyses, different conclusions and recommendations were made. In this research, a total number of 150 questionnaires were administered and 105 were retrieved. The characteristics of the respondents are shown below:-

VI. Personal Profile of the Respondents

Table 1 shows the distribution of respondents by their organization. It is shown that 92.40% of the organizations were nationals of this country while the remaining were foreigners. This is an indication that most of the construction organizations in Lagos and Ibadan are owned by Nigerians. The table shows that the bulk of respondents, 52.40% worked with large-sized organizations, 33.30% worked with medium-sized organizations while the remaining 14.30% were working with small-sized organizations. This indicates that there are more large organizations than medium organizations in Lagos and Ibadan and the sizeable number of artisans in their employment would have great understanding of the concept of stress based on the nature of their work. The table shows that most of the respondents (58.10%) worked with building construction firms while those who worked with building construction and civil engineering firms were 28.60%, those that worked with civil engineering firms were 7.60% and those that worked with other types of firms as may be designated were 5.70%. This simply indicates that data were collected mostly from artisans that worked in building construction firms.

An examination of the table shows that artisans that have worked within 6-10 years were much in construction firms (49.5%).Those that worked within 1-5 years were about 5.70%, those that worked within 11-15 years were 25.70%, those that worked within 16-20 years were 12.40%, those that worked within 21-25 years were 6. 70% and none of the respondents had worked for more than 25 years. This is an indication that the years of experience of the respondents in construction industry would offer them good and reasonable understanding of stress and its related effects on occupational performance and emotional build-up. An in-depth interpretation of the table presented shows that much percentage of artisans were not educated; they passed through Trade Test Programme (58.10%), 28.60% were Primary Leaving Certificate holders, about 6.70% passed through both SSCE (Senior School Certificate Examination) and JSCE (Junior School Certificate Examination) while none of the respondents was an OND (Ordinary National Diploma) holder.

It is shown that 33.70% of the respondents were bricklayers, 15.30% were carpenters, 14.30% were iron benders, 5.70% were tillers, 5.70% were plumbers, 7.60% were concreters, 6.70% were painters, while the remaining percentage, 15.20% wereinvolved in other trades besides those listed in the table. This is an indication that a sizeable number of the respondents were into bricklaying and with the dispersal of the artisans into different trades; information gotten from them would reflect issues of stress among artisans in Nigerian construction industry. The table also shows the distribution of respondents by their sex. All the respondents were male 100.00%. This shows that only males were mostly employed as artisans in the construction industry in the country possibly because males are stronger than females and can cope with occupational stress encountered in construction works. The table also shows that almost all the respondents were married (89.50%) while 10.50% of the respondents were single.

Table 1 : Profile of Respondents

Percentage Distribution of Respondents by Nature of Employers		
Nature of Employers	Frequency	Percentage
Foreign	8	7.60
Indigenous	97	92.40
Total	105	100.00
Percentage Distribution of the Respondents by Size of the Organisations		
Size of Organisation	Frequency	Percentage
Large	55	52.40
Medium	35	33.30
Small	15	14.30
Total	105	100.00
Percentage Distribution of Respondents by Type of Projects		
Type of Projects	Frequency	Percentage
Building Construction	61	58.10
Civil Engineering	8	7.60
Both	30	28.60
Others	6	5.70
Total	100	100.00
Percentage Distribution of Respondents by Years of Experience		
Years of Experience	Frequency	Percentage
1-5	6	5.70
6-10	52	49.50
11-15	27	25.70
16-20	13	12.40
21-25	7	6.70
Above 25	0	0.00
Total	105	100.00
Percentage Distribution of Respondents by Educational Qualification		
Qualifications	Frequency	Percentage
OND	0	0.00
Trade Test	61	58.10
SSCE	7	6.70
JSCE	7	6.70
Primary Leaving Certificate	30	28.60
Total	105	100.00
Percentage Distribution by Sex of Respondents		
Sex	Frequency	Percentage
Male	105	100.00
Female	0	0.00
Total	105	100.00
Percentage Distribution of Respondents by Marital Status		
Marital Status	Frequency	Percentage
Married	94	89.50
Single	11	10.50
Total	105	100.00
Percentage Distribution of Respondents by Type of Trades		
Type of Trade	Frequency	Percentage
Bricklaying	33	33.40
Carpentry	15	14.30
Iron Bending	14	13.30
Tiling	6	5.70
Plumbing	6	5.70
Concreting	8	7.60
Painting	7	6.70
Others	16	15.20
Total	105	100.00

VII. Artisans and Stress

Table 2: Percentage Distribution of respondents on whether they have experienced stress in the period under review or not

Experienced	Frequency	Percentage
Yes	98	93.30
No	**7**	6.70
Total	105	100.00

An examination of Table 2 shows that the respondents who indicated that they experienced stress were 93.30% while the remaining 6.70% noted that they did not experience stress. This means that this frequency count would help in having reliability of the data gotten on the causes and effects of stress and the possible ways to manage it. Table 3 shows the percentage distribution of respondents by sources of stress. About 87.60% of stresses experienced by respondents were from their jobs. This supports the position maintained by the artisans during interview that they experience stress mostly from their jobs.

Sources of stress	Frequency	Percentage
Job	92	87.60
Other Source(s)	13	12.40
Total	105	100.00

VIII. STRESSORS

From Table 4, it is observed from the work related section that qualitative work overload has the highest mean score of 3.70 which indicates that work overload is the most rated factor that causes stress among artisans in construction industry in Nigeria. Also, during the interview part of the data collection, the respondents; the artisans maintained that at times they might not have the required knowledge to complete the work assigned to them satisfactorily. Also, from the work time related section, the quantitative work overload has the highest mean score of 3.70 which the artisans noted during the interview that; their working list is too long to complete. This is a potential stressor on their part. Tight-time frame for works has mean score of 3.39. It can be concluded from this that a very short time-frame to complete the work ahead is one of the stressors confronted by the artisans that make them to work overtime.

From the organizational policy related section, it is observed that inadequate knowledge of the of project objectives has the highest mean score of 3.13 which simply means that; artisans suffer from inadequate knowledge of project objectives (that is, the project objectives have not been clearly conveyed to different working levels). Another stressor in this section that possessed the next highest index value is the conflicts among different job demands in different sites and locations. It has a mean score of 2.67. It was confirmed from the artisans during the interview that artisans work in more than one project and they find it difficult to have a stable mind-set for each of them. Result from the also revealed that; at the organizational position related section, unsatisfied salary has the highest mean score of 3.74.This indicates the rate at which the personnel at higher hierarchy in construction are treating personnel at lower hierarchy like artisans is not encouraging. According to the respondents during the interview, they said they were the ones doing the real work on site, handling harmful materials, directly involved in the physical construction of projects, and at the same time, they are the ones earning the least wages/salary. This is unlike personnel in the middle and top hierarchies in the industry that get more fantastic packages and equally reviewed upwardly at a rate faster than that of the artisans.

It was also observed from Table 4 that role conflicts (where there may be occasions of conflicts between their roles in the organization and that under individual project) is the most rated stressor among the situational/environmental factors/stressors. It has the highest mean score of 3.63. Also, different views from the superiors, has mean score of 3.46. This was confirmed during the interview as the respondents complained about different site engineers and supervisors that assess their work. They said what satisfies one might not satisfy another as conflicts normally exist in the site instructions passed. The table also revealed that low recognition received from work causes stress for the respondents. This has a mean score of 2.64.The respondents also complained during the interview that their superiors do not appreciate their efforts all the time. They also complained about poor communication with counter players and problem with their superior management style which were all confirmed from the table by having mean score of 2.16 and 2.45 respectively.

Table 4: Distribution of Respondents by Rating of Job-Related Stressors

JOB RELATED PROBLEMS/STRESSORS	1	2	3	4	5	Mean Score	Overall Ranking
A. WORK NATURE RELATED							
1.Qualitative work overload	16	6	20	14	49	3.70	1
2.Too specialized job nature	47	0	36	6	16	2.47	2
3.Job nature renders too much contact with people	79	0	6	6	14	1.82	3
4.Low job challenges	70	14	13	8	0	1.61	4
B. WORK TIME RELATED							
1.Quantitative work overload	16	6	20	14	49	3.70	1
2.Tight timeframe for work	8	13	14	70	0	3.39	2
3.Unstable working hours	0	14	0	77	0	3.20	3
4.Work under load	60	8	31	0	6	1.90	4
C. ORGANISATIONAL POLICY RELATED							
1.Inadequate knowledge of project objectives	14	11	18	0	55	3.13	1

2.Conflict among different working demands	14	28	70	0	0	2.67	2
3.Adaptability problem with change of job Natures	40	6	32	21	6	2.50	3
4.Inadequate room for innovation	42	12	29	14	8	2.37	4
5.Bureaucracy	56	6	16	20	7	2.20	5
D. ORGANIZATIONAL POSITION RELATED							
1.Unsatisfied salary	15	12	15	6	57	3.74	1
2.Inadequate authority	0	14	0	77	0	3.20	2
3.Lack of career guidance	35	0	36	20	14	2.79	3
4.Lack of job stability	56	14	21	6	8	2.01	4
5.Lack of promotion opportunity	79	0	6	6	14	1.82	5
6.Ambiguity on job requirement	69	12	16	8	0	1.65	6
E. SITUATIONAL/ENVIRONMENTAL							
1.Role conflicts	0	9	19	14	50	3.63	1
2.Different views from superior	14	10	18	0	55	3.46	2
3.Poor working condition	21	0	36	26	22	3.27	3
4.Exposure to dangerous working condition		20	0	0	60	3.23	4
5.Unfair assignment of workload	56	14	21	6	8	2.01	5
F. RELATIONSHIP RELATED							
1.Low recognition received from work	50		15	18	22	2.64	1
2.Problem with superior management style	41	16	22	12	14	2.45	2
3.Poor communication with superior	55	14	6	30	0	2.16	3
4.Poor relationship with colleague	53	14	8	30		2.14	4
5.Poor communication with counter player	63	12	16	14		1.82	5
G. PERSONAL							
1.Work-family conflicts	15	12	16	41	21	3.39	1
2.Inadequate recess	40	6	32	21	6	2.50	2
3.Problem with ability application	69		6	14	16	2.12	3
4.Lack of opportunity to learn new skill	70	12	16	41	21	1.13	4

t is shown in Table 5 that majority of the respondents (71.40%), claimed that they do not encounter stressors at home front as they do at work. This was also buttressed in Table 2 when 87.60% of the respondents noted that the major sources of their stresses are in job affairs. About 28.00% of the respondents affirmed that they do experience issues that cause stress at home front. This simply indicates that artisans experience much stresses at work than at home. From the table, it is observed that quarreling gives respondents much stress (47.6%) than any other social behaviour. The other social behaviours that induce stress are by these frequencies: drinking (23.80%), flirting (14.30%, smoking (9.50%) and clubbing (4.80%). It is shown that bulk of the respondents (74.30%) responded positively to the question above while the remaining 25.70% responded negatively. This is an indication that stress causes a lot of medical ailments among the respondents (artisans). Result from the table shows that 47.60% of the respondents were affected mostly by depression, 9.50% were affected by psycho-physical illness (hypertension), 4.80% were affected by cancer, 19.00% were affected by wound (delay in wound healing process), 5.70% were affected by emotional disturbance, 4.80% were affected by behavioural disorders (impatience/aggressiveness), 4.80% were affected by mental effect (negative thinking) while the remaining 3.80% were

affected by other ailments like headache, body pains and so on.

Table 5: Stress and Artisans Working in Construction Industry

Distribution of respondents by whether they are facing problems at home front or not		
Response	Frequency	Percentage
Yes	30	28.60
No	75	71.40
Total	105	100.00
Percentage Distribution of social behaviours that give respondents stress		
Social Behaviour	Frequency	Percentage
Drinking	25	23.80
Quarrelling	50	47.60
Clubbing	5	4.80
Flirting	15	14.30
Smoking	10	9.50
Total	105	100.00
Percentage Distribution of respondents by the effects of stressors on their health		
Do Stressors Cause Medical Effects	Frequency	Percentage
Yes	78	74.30
No	27	25.70
Total	100	100.00
Percentage Distribution of respondents by the types of ailments affecting them.		
Types of Ailment	Frequency	Percentage
Depression	50	47.60
Psycho-physical illness(hypertension)	10	9.50
Cancer	5	4.80
Wound(Delay in wound healing process)	20	19.00
Emotional Disturbance	6	5.70
Behavioural(Impatience/Aggressiveness)	5	4.80
Mental Effect(Negative Thinking)	5	4.80
Others	4	3.80
Total	105	100.00

IX. STRATEGIES TO MANAGE STRESS

Result from Table 6 shows that majority of the respondents chose resorting to hobbies and exercises as the emotion-focused strategy they regularly adopt to effectively manage stress. From the table, it has a mean score of 2.92. The next strategy to this is seeking for caring and social support (mean score of 2.66) which was confirmed during the interview from the respondents as what every artisan needs at every time to wave away stress. Majority of the respondents (100.00%) with a mean score of 3.00 chose planning ahead as a strategy to cope with stress. This is the same with that of setting and dealing with problem accordingly. This is an indication that planning ahead and setting and dealing with problems accordingly are problem-focused coping strategies to be adopted

In Table 7, 42.90% of respondents chose relaxation as the most comfortable strategy of coping with stress. According to the respondents during the interview, they said; relaxation after daily work is good for people like them based on the energy exerted during their daily works. About 26.60% of the respondents chose aerobic exercise as a strategy of coping with stress. Some of the respondents (19.10%) chose social support as their own-adopted method of coping with stress while 5.70% chose both laughter and biofeedback as their own strategy of coping with stress. This indicates that relaxation and aerobic exercise strategies are crucial for managing stress among artisans in construction industry. The results of Table 8 shows that majority of the employers/organizations do not provide any stress management strategies for the artisans except time-off measure (sick leave) and social activities measure (Dinner Party, New Year/Festival Celebrations). This is mainly because an ill person will definitely be absent from work (coming to site). And it was discovered that dinner party, new year/festival celebrations are seasonal. At this time, the respondents posited that there used to be scarcity of building materials which affect smooth running of jobs at site would keep them away from work and thus prevent artisans from job-related stress factors during the period.

Table 6: Strategies Used to Manage Stress

Distribution of Respondents by Emotional-Focused Coping Strategy

RATING

Emotional-Focused Coping Strategy	Never	Rarely	Often	Mean Score	Ranking
Resorting to hobbies and exercises	0	8	97	2.92	1
Seeking for caring and support	0	15	90	2.86	2
Talking/Listening to friends	0	36	69	2.66	3
Expanding interest/activities after work	21	20	64	2.41	4

Distribution of Respondents by Problem-Focused Coping Strategy

RATING

Problem-Focused Strategy	Never	Rarely	Often	Mean Score	Ranking
Planning ahead	0	0	105	3.00	1
Setting and dealing with problem accordingly	0	0	105	3.00	1
Effective time management	16	21	68	2.50	3
Dealing with problem in an unemotional way	60	24	20	1.62	4
Concentrating on specific problem	60	37	8	1.50	5

Table 7: Percentage of Respondents by Strategies Used to Manage Construction Stress

Strategies	Frequency	Percentage
Aerobic Exercises	28	26.60
Biofeedback	6	5.70
Relaxation	45	42.90
Laughter	6	5.70
Social Support	20	19.10
Total	105	100.00

Table 8: Stress Management Strategies Employed by Employers

Proactive Measure

Response	Frequency	Percentage
Yes	35	33.30
No	70	66.70
Total	105	100.00

Non-Specialist Assistance Measure

Response	Frequency	Percentage
Yes	56	53.30
No	49	46.70
Total	105	100.00

Specialist Assistance Measure

Response	Frequency	Percentage
Yes	8	7.60
No	97	92.40
Total	105	100.00

Restructuring of Social and Physical Work Environment

Response	Frequency	Percentage
Yes	20	19.00
No	85	81.00
Total	100	100.00

Time-Off Measures (Sick Leave)

Response	Frequency	Percentage
Yes	76	72.40
No	29	27.60
Total	105	100.00

Social Activities Measure

Response	Frequency	Percentage
Yes	61	58.10
No	44	41.90
Total	105	100.00

X. Conclusion

As construction work is one of the occupations most vulnerable to stress, the result of this study suggests that construction industry needs to urgently address the problems and management of stress among artisans in the industry. In terms of stressors, those confirmed in respect to this study are qualitative and quantitative work overload, too specialized job nature, tight-time frame for works, unstable working hour, inadequate knowledge of project objectives, conflicts among different job demands, inadequate room for innovation, bureaucracy, unsatisfied salary, lack of career guidance, lack of job stability, lack of job opportunity, different view from superior, role conflicts, unfair assignment of workload, poor working environment, exposure to dangerous working conditions, low recognition received for work done, poor communication with superiors and counter players, work-family conflicts, inadequate recess and lack of opportunity to learn new skills. People react differently to stress; the same applies to artisans in construction industry. Respectful and considerate management can help the artisans in getting through difficult times of stress. When stressful situations arise in the work environment, it is important that the company's management and the artisans jointly address the stressors in the work environment through artisans participating in assessing the problem; communicating potential resolutions and recognizing that stress management is a joint effort. Most importantly, aerobic exercises, biofeedback, relaxation, laughter, social supports are all ways of managing stress especially among artisans in construction industry. A stress- free environment begins with a stress-free individual.

XI. Recommendation

1. Every construction firm must be concerned with providing stress management strategies for artisans. These strategies could be proactive measures like training workload, adjustment, stress identification, creating social structures and role clarification.
2. Construction firm should provide special assistance measure for artisans in terms of professional advisers and health interventions.
3. Restructuring of social, physical and work environment should be the target of every construction organization.
4. There should be a provision for time-off measure (not only sick leave) for the artisans in construction industry as this gives room for thorough relaxation.
5. There should be improvement of social activities measures for the artisans.
6. The artisans should be paid in correlation with their work load.
7. The personnel in higher hierarchy in construction industry should know that without artisans, nothing could be done on construction sites, hence they need to recognize and respect and adequately remunerated with upward review of their wages/salaries periodically.
8. Bad and abusive languages in addressing the artisans should be stopped by their superiors.
9. Every organization (large, medium and small size) should provide safety measures for the well-being of artisans to protect them from harsh weather conditions, undue exposure to dangerous working conditions and reactions to hazardous building materials.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.

You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described.
Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work

- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals:

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.

Written Material: You may discuss with your guides and key sources.

- Do not copy or imitate anyone else paper. (Various Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper *(Compilation)*
by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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