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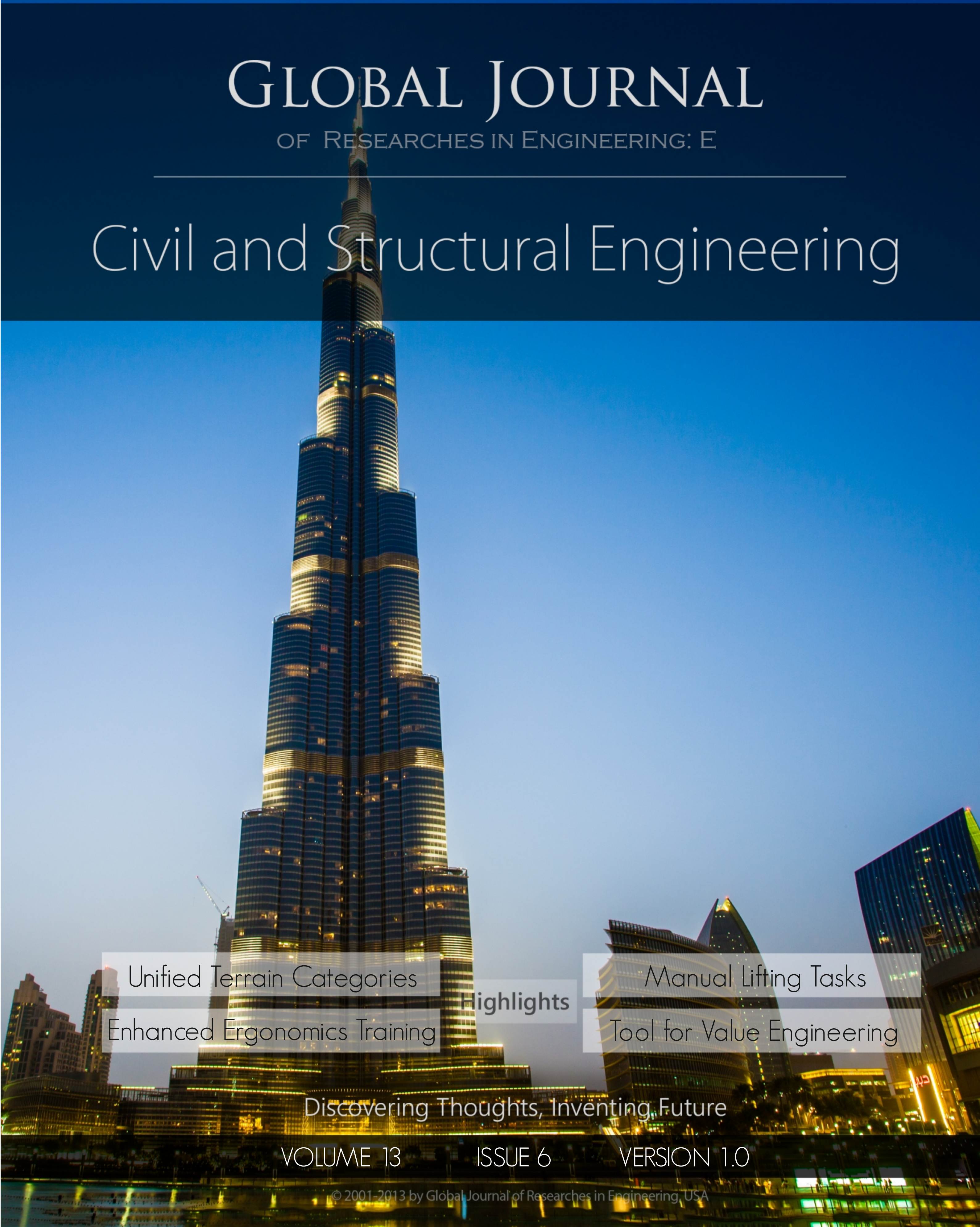

Highlights

Unified Terrain Categories

Enhanced Ergonomics Training

Manual Lifting Tasks

Tool for Value Engineering

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 6 VERSION 1.0

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An Extensive Evaluation of the Proposal for "Unified Terrain Categories Exposures and Velocity Profiles" by Choi (2009)

By S. A. Hsu
Louisiana State University, USA

Abstract - The proposal for "unified terrain categories exposures and velocity profiles" by Choi in 2009 has been evaluated extensively. On the basis of 6 articles in open literature (3 papers during Typhoon Muifa in 2011, one during Hurricane Ike in 2008, one during Typhoon Sally in 1996, and one during an atmospheric dispersion experiment in New York City, USA) and nearly simultaneous upper-air measurements when available, it is found that the proposed criteria (except the displacement height) by Choi are evaluated to be useful operationally for engineering applications. An alternative approach using the mean building height (rather than the displacement height)as the input to estimate the power-law exponent and the gradient height is proposed for practical use.

Keywords : Typhoon Sally, Typhoon Muifa, Hurricane Ike, tall buildings, power-law exponent, roughness length, grad ient height, displacement height, terrain exposures, velocity profiles.

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ANEXTENSIVEEVALUATIONOFTHEPROPOSALFORUNIFIEDTERRAINCATEGORIESEXPOSURESANDVELOCITYPROFILESBYCHOI2009

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Keywords: Typhoon Sally, Typhoon Muifa, Hurricane Ike, tall buildings, power-law exponent, roughness length, gradient height, displacement height, terrain exposures, velocity profiles.

I. Introduction

Building or structural damages by storms, whether they are tropical or extra-tropical cyclones, require an estimation of wind speed. Numerous methodologies have been proposed and used (see, e.g. Wieringa, 1992, Zhou and Kareem, 2002, and Irwin, 2006). Most recently, Choi (2009) has proposed his "Unified Terrain Categories Exposures and Velocity Profiles" as presented in Table 1. The purpose of this study is to evaluate Table 1.

Table 1 : Terrain Categories and Related Parameters as proposed by Choi (2009)

Category	Exposure (description)	Roughness Length, meters	Power-law exponent	Gradient Height,meters	Displacement Height, meters
Cat I	Open water (open sea or lake and coastal areas with few obstructions)	0.002	0.103	250	5
Cat II	Open country (terrain with scattered obstructions up to 10 m high. Rural areas with a few low rise buildings)	0.04	0.15	350	5
Cat III	Forest/Sub-urban scattered low (3-5 m) buildings (numerous closely spaced 3-5 m obstructions)	0.2	0.198	450	10
Cat IV	Urban, large town (many medium height (10-50 m) buildings)	0.5	0.241	500	15

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Cat V	City (medium height buildings mixed with tall (50m+) buildings)	1.0	0.289	550	20
Cat VI	City center (concentration of very tall buildings mixed with other buildings)	>=2	0.362	650	30

II. An Evaluation During Typhoon Muifa in 2011

During Typhoon Muifa in 2011 there are 3 studies which can be used for our evaluation. They are:

a) Wind Measurements at Two Locations on the Sutong Bridge

According to Xu et al (2013), the SutongBridge across the low reaches of the Yangtze River in China is a cable-stayed bridge with its longest span, which is under constant monitoring because of tropical cyclones and other strong winds. During Typhoon Muifa in 2011, there were two anemometers on the bridge. The mean wind speed measured at 76m was 17.08 m/s and at 300.4 m 19.58 m/s, respectively. Using the power-law wind profile formula (see, e.g. Hsu, 1988), we have

$$U2/U1 = (Z2/Z1)^p \qquad (1)$$

$$Z2 > Z1$$

$$P = Ln\,(U2/U1)/\,Ln\,(Z2/Z1) \qquad (2)$$

So that,

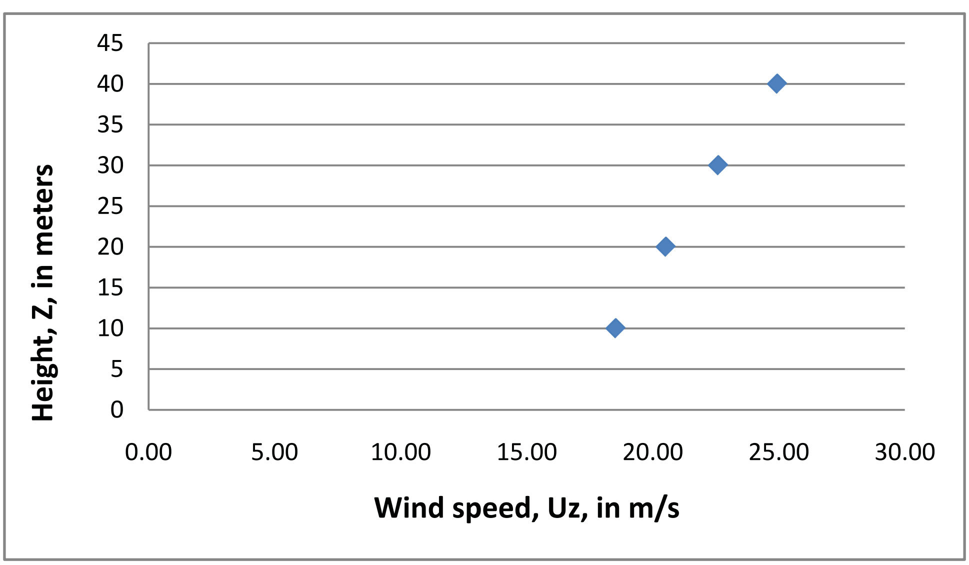
$$p = Ln\,(19.58/17.08)/Ln\,(300.4/76) = 0.099 = 0.100$$

Note that U2 and U1 are the wind speeds at height Z2 and Z1, respectively. P is the exponent of the power law.

Now, compare this over-water p (=0.100) with that in Table 1 for open water in Category I in which p = 0.103, we can say that the agreement is excellent. Note that the p (=0.10) value has been measured over the Sicily Strait by Hsu(1988), over the Gulf of Mexico by Hsu et al. (1994) under fair weather condition and by Hsu (2011) under hurricane condition.Note also that these measurements on the Sutong Bridge are unique in that it was over a large (the Yangtze)river.

b) Wind Profile Measurements on the East Coast of Shanghai, China

During Typhoon Muifa in 2011, Peng et al (2013) present a study with the measurements of the wind speed at 4 levels from 10 to 40 meters. These data are plotted in Fig. 1.



(Data Source : Peng et al, 2013)

Figure 1 : Measurements of the wind speed at 4 levels from 10 to 40 m on the east of Shanghai, China, during Typhoon Muifa in 2011

While the power law has been discussed above, the log law is presented as follows:

In the atmospheric boundary layer, vertical distribution of the wind speed (under strong wind conditions so that the thermal effects may be neglected, see Hsu, 2003) can be formulated according to the logarithmic wind profile (e.g. Panofsky and Dutton, 1984) as:

$$Uz = (U^*/k) \ Ln \ ((Z-d)/Z_0) \qquad (3)$$

Where Uz is the wind speed at height Z, U* is the friction velocity, k (=0.4) is the von Karman constant, d is the displacement height, and Z0 is the roughness length.

Note that when Z is much larger than d, Eq. (3) may be reduced to

$$Uz = (U^*/k) \ Ln \ (Z/Z_0) \qquad (4)$$

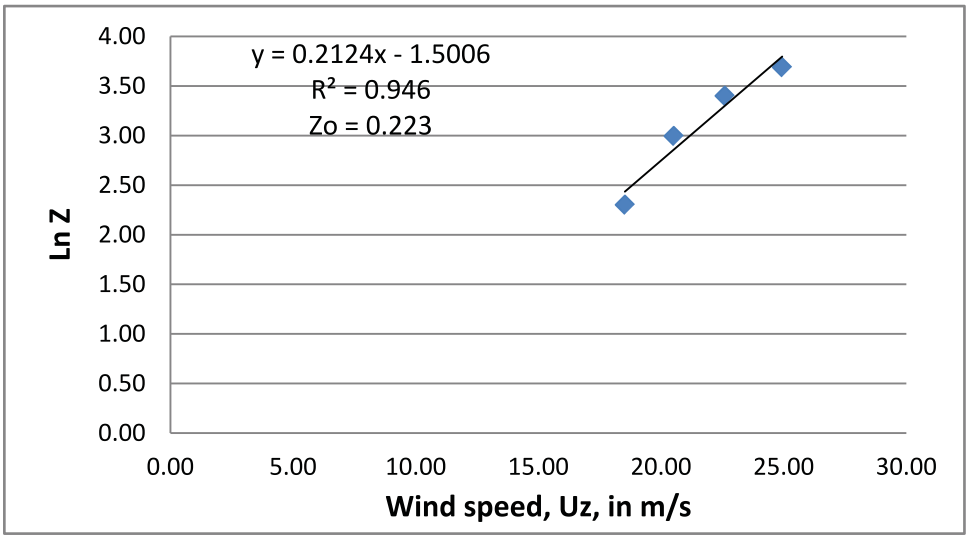
Statistically, Eq.(4) can be written as

$$Ln \ Z = Ln \ Zo + (k/U^*) \ Uz \qquad (5)$$

$$Y = a_0 + a_1 X$$

Where $Y = Ln \ Z$, $X = Uz$, and $Zo = Exp(a_0)$ (6)

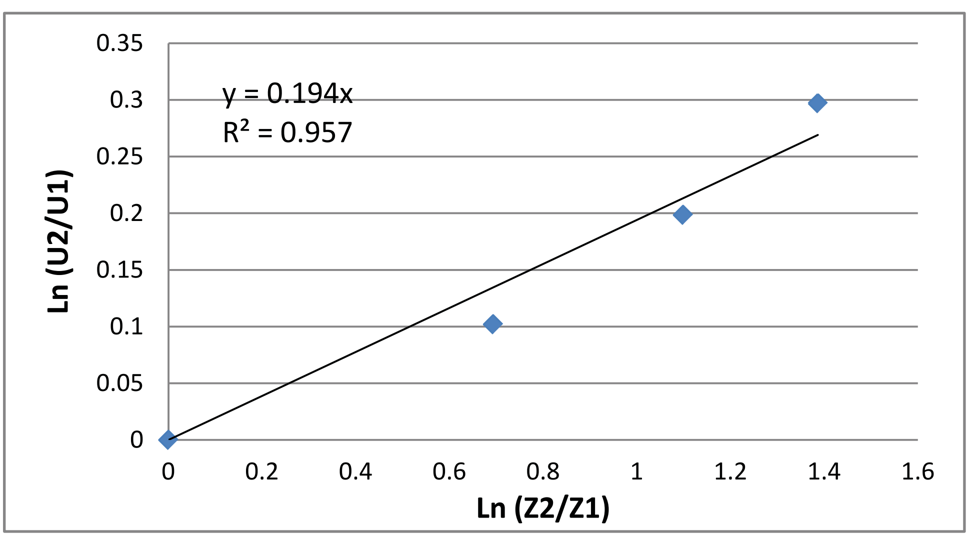
Analysis of the log law is presented in Fig. 2. Since approximately 95 per cent of the wind speed variation with height can be explained by this law (because $R^2 = 0.95$), we can get Zo = 0.223.



(Data Source : Peng et al, 2013)

Figure 2 : Verification of logarithmic wind profile during Typhoon Mufia in 2011 on the east coast of Shanghai, China

Analysis of power law is provided in Fig. 3, which demonstrates that nearly 96 per cent of the wind speed variation with height can be explained by the power law so that p = 0.194. Note that since R2 is higher for the power law than that for the log law, we can say that the former is as good as the latter for engineering applications.



(Data Source : Peng et al, 2013)

Figure 3 : Verification of power-law wind profile during Typhoon Mufia in 2011 on the east coast of Shanghai, China

Now, comparison of theseZo = 0.223 and p = 0.194 values to those in Table 1, we can see that the measurement site in Peng et al (2013)was located at Category III. Since values of Zo and p are consistent with those provided in Table 1, we can say that Cat. III is verified.

c) Wind speed measurements at 494 m atop the Shanghai World Financial Center during Typhoon Muifa in 2011

An et al (2012) present their wind measurements atop the Shanghai World Financial Center (SWFC) during Muifa. The maximum 10-min mean wind speed reaches 32.97 m/s at 494 m on the rooftop. With this data we can evaluate Cat. VI using Table 1 that p = 0.198 for Cat. III. First, we need to estimate the wind speed at 450 m by applying the power law as follows:

$$U_{450m} / U_{10m} = (450/10) \wedge 0.198 = 2.12$$

$$U_{450m} = 18.53 * 2.12 = 39.37 \text{ m/s}$$

This value is expected to be the same at 650 m over SWFC.

Now, the wind speed at 494 m atop SWFC is estimated to be

$$U_{494m} = U_{650m} * (494/650) \wedge 0.362 = 39.37 * 0.91 = 35.65 \text{ m/s}$$

Since the difference between estimated wind speed (35.65 m/s) and the measured (32.97) is approximately 8 per cent, which is within the 10 percent margin of error for the composite accuracy of the field measurement in wind speed (see www.ndbc.noaa.gov) , we can say that Table 1 is evaluated to be useful.

d) Upper-air Measurements from Shanghai during Muifa

As indicated in Table 1, the gradient height over a large city is 650 m. Since there is no wind measurement at this altitude at present time, we employ the routine upper-air sounding called rawinsonding instead. According to Geer (1996), rawinsonde is a method of upper-air observation consisting of an evaluation of the wind speed and direction, as well as temperature, and humidity aloft by means of a balloon-borne radiosonde (instrument package) tracked utilizing position change as determined by directional radio techniques. Note that rawinsonde measurements are routinely available twice per day at many places around the world including Shanghai, China (see www.-ncdc.noaa.gov).

Before the analyses of upper-air data are performed, the concept of virtual potential temperature, θv, needs to be discussed briefly, since it can serve as a stability criterion for an atmosphere with a moisture gradient.For more detail, see Stull (1988). For our analyses, we need to know that when θvis constant, the atmospheric boundary layer is statically neutral. When it decreases with height, the atmosphere is statically unstable. When it increases with elevation, the atmosphere is statically stable. Since the power-law wind profile is valid within a neutral boundary layer, we need to plot this virtual potential temperature value with height so that the gradient height can be determined.

Figs. 4 thru 9 show our results during Typhoon Muifa in 2011 near Shanghai. It can be seen from Figs. 6 and 9 that the average gradient height during these two rawisondings is (677 + 611)/2 = 644 m, which is close to the value of 650 m as proposed in Table 1 for Category VI.Note that at 12Z on 06 August 2011, the wind was light and variable near the ground as shown in Figs. 4 and 5, but at 611 m, the wind speed was 17 m/s and direction from 40 degrees. Similar condition was prevailed 12 hours later (Figs. 7 and 8), but the direction was from 315 degrees with a speed of 7.2 m/s near the ground. At 611m, the speed increased to 26.3 m/s and the direction was from 340 degrees.

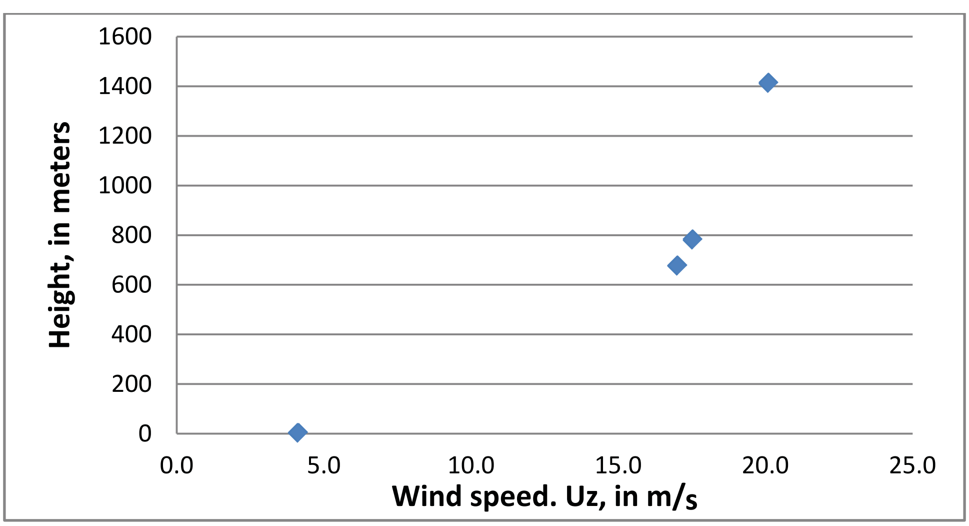


Figure 4 : Rawinsonding of wind speed from Shanghai, China, at 12Z on 06 Aug 2011 during Typhoon Muifa

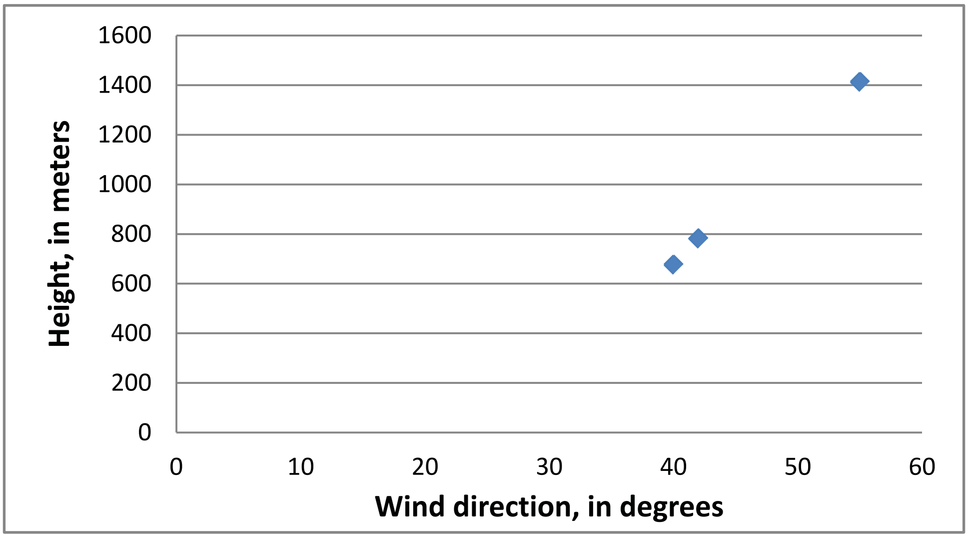


Figure 5 : Rawinsonding of wind direction from Shanghai, China, at 12Z on 06 Aug 2011 during Typhoon Muifa

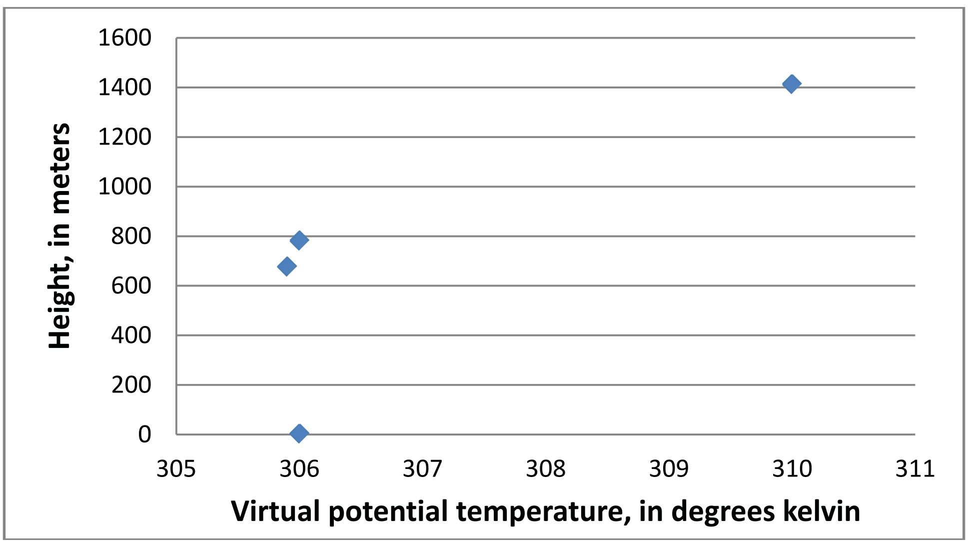


Figure 6 : Rawinsonding of virtual potential from Shanghai, China, at 12Z on 06 Aug 2011 during Typhoon Muifa

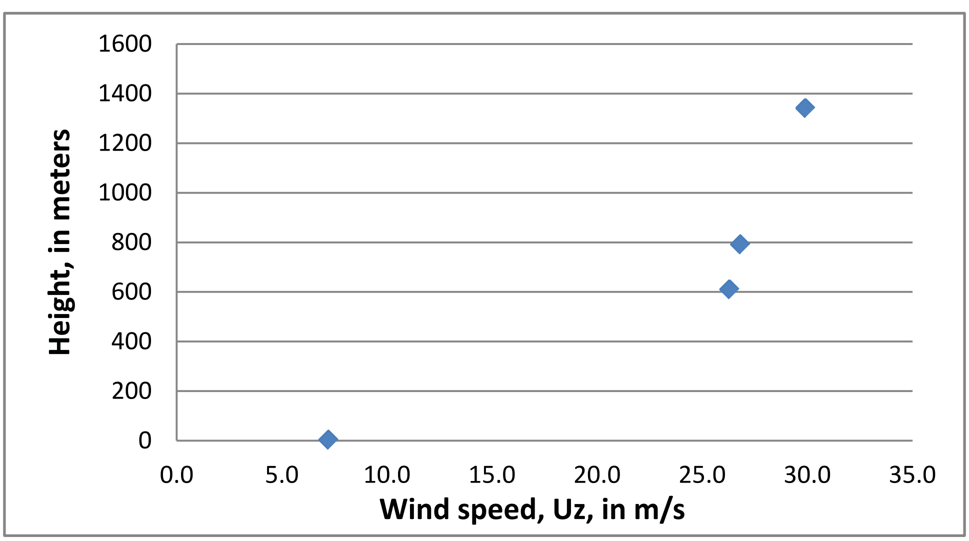


Figure 7 : Rawinsonding of wind speed from Shanghai, China, at 00Z on 07 Aug 2011 during Typhoon Muifa

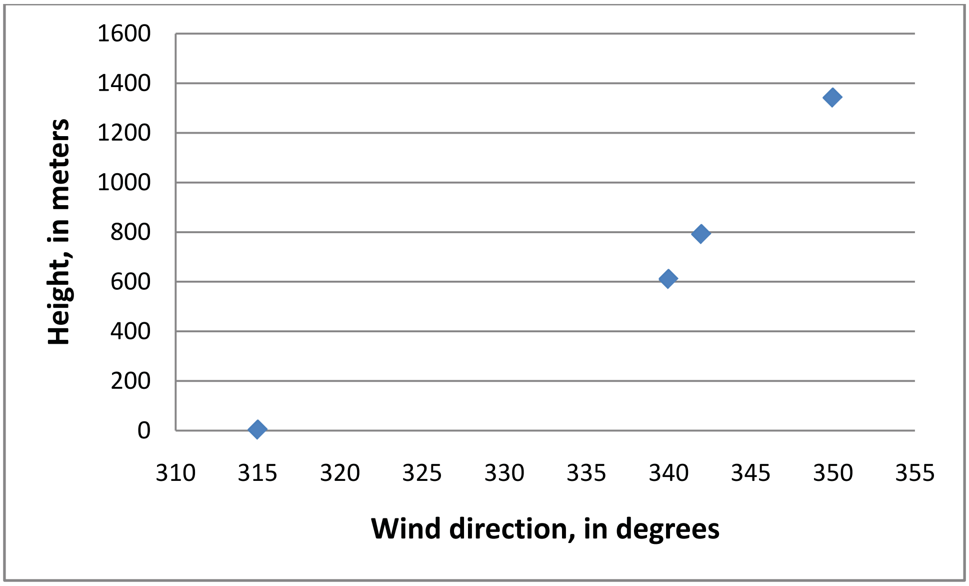


Figure 8 : Rawinsonding of wind direction from Shanghai, China, at 00Z on 07 Aug 2011 during Typhoon Muifa

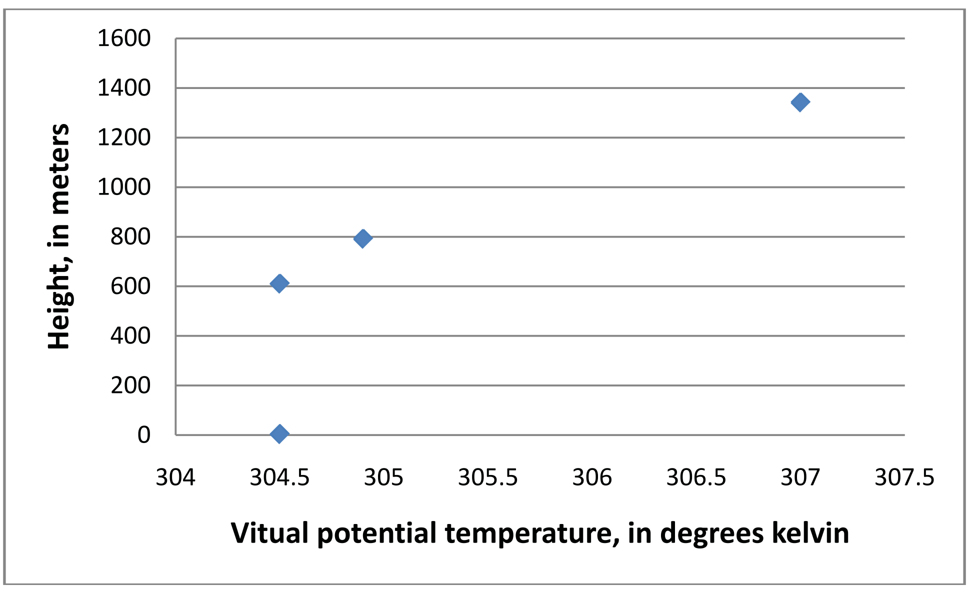


Figure 9 : Rawinsonding of virtual potential temperature from Shanghai, China, at 00Z on 07 Aug 2011 during Typhoon Muifa

III. An Evaluation using Measurements in New York City

a) Validation of The Power-Law Exponent

Hanna et al (2007) present wind measurements during the Manhattan Madison Square Garden in New York City (NYC), USA, urban field experiments during 2005 suitable for our evaluation. Specifically, on 10 March 2005, there were 3 wind speed and direction measurements on three rooftops ranging from 34 to 229 m as shown in Fig. 10. A validation of the power law based on Eq. (1) is presents in Fig. 11, which also indicates that the exponent is determined to be 0.35. This value is close to 0.362 as proposed in Table 1 for Category IV.

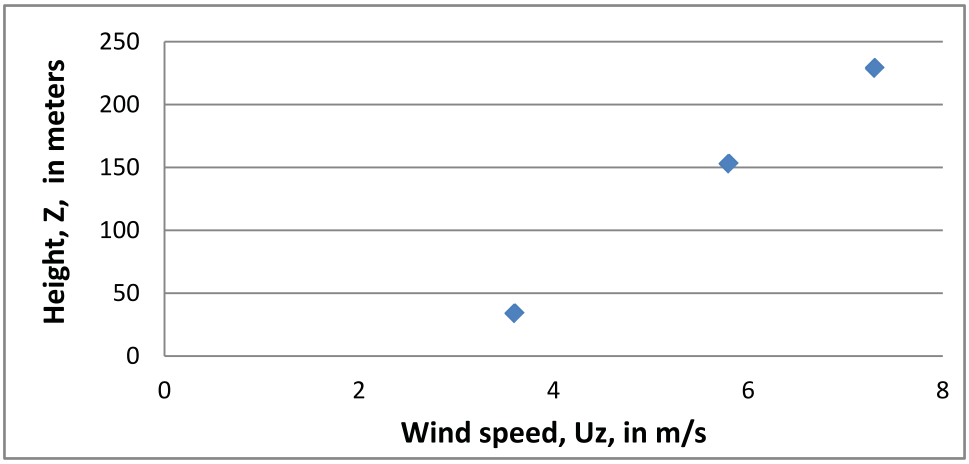


Figure 10 : Measurements of the wind speed on 3 rooftops in New York City by Hanna et al. (2007, Table 3)

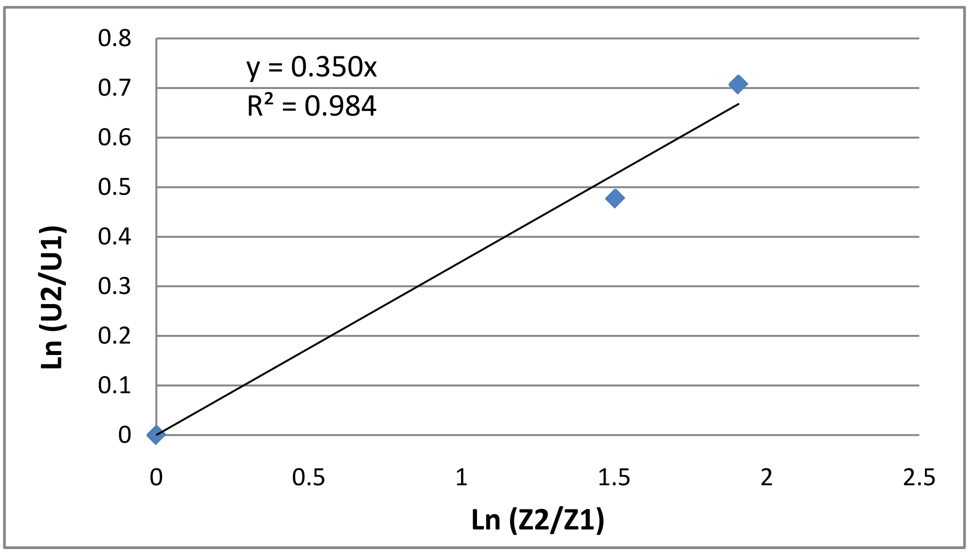


Figure 11 : Validation of the power-law wind profile based on data provided in Figure. 10 in New York City

b) Verifications of Wind Speed at 3 Elevations

Hanna et al (2007) also provided the wind measurement of 6.2 m/s at the standard 10 m height from nearby JFK Airport. We can now evaluate Table 1 using this JFK data as follows:

First, we need to calculate the wind speed at the gradient height for Category II such that, from Eq. (1),

$$U_{350m} = U_{10m} * (350/10) \wedge 0.15 = 6.2 * 1.70 = 10.6 \text{ m/s},$$

From Table 1, this value is expected to be the same as that of the wind speed at 650 m over NYC. So, we set U_{650m} = 10.6 m/s tocompute the wind speeds located at the three rooftops.

For the rooftop at 229m, we have

$$U_{229m} = U_{650m} *(229/650) \wedge 0.362 = 10.6 * 0.69 = 7.3 \text{ m/s},$$

$$U_{153m} = U_{650m} *(153/650) \wedge 0.362 = 10.6 * 0.59 = 6.3 \text{ m/s, and}$$

$$U_{34m} = U_{650m} *(34/650) \wedge 0.362 = 10.6 * 0.34 = 3.6 \text{ m/s}.$$

These computed values are listed in Table 2 so that they can be compared to the measurements as provided in Hanna et al (2007). Since the margin of error in wind speed measurement is 10 % as stated above, we can say based on Table 2, that the agreements are excellent and Table 1 is evaluated here as useful.

Table 2 : Comparisons between the computed and measured wind speeds at 3 heights in NYC (Data source: Hanna et al, 2007)

Rooftop height, m	Measured Wind speed,m/s	Computed Wind speed, m/s	Difference in Per cent
229	7.3	7.3	0 %
153	5.8	6.3	8 %
34	3.6	3.6	0 %

IV. An Evaluation using Measurements in Houston, Texas, during Hurricane Ike in 2008

When Hurricane Ike passed over the City of Houston, Texas, in September 2008 (see Berg, 2008), there were two wind speed measurements at 20 and 60 meters on a 91 meter communication tower (see Schade, 2012)which are useful for our evaluation as follows:

a) A Comparison of Boundary-layer Parameters with Table 1

According to Schade (2012), several boundary-layer parameters are available for the comparison as shown in Table 3. It can be seen that the Tower in Houston is located in Category V. While both values of roughness parameter and power-law exponent are in excellent agreement, the displacement is not. A recent study of zero-plane displacement height, d, in a highly built-up area of Tokyo shows that the value of d may not be determined from the average building height because ofthe large difference in building heights (see Tanaka et al., 2011). Therefore, values of the displacement height as listed in Table 1 needto be further evaluated. But, for now, it is listed only as a general guide.

Table 3 : A comparison of boundary-layer parameters. Source Roughness

Source	Roughness Length, Zo, m	Power-law Exponent, p	Displacement Height, m
Houston Tower	1.0	0.29	8
Table 1	1.0	0.289	20

b) A Comparison of Wind Speed Measurements

In order to evaluate the tower measurements from Houston, we need to first determine the power-law exponent from nearby Hobby Airport, which was not exactly located in open country but between Categories II and III. This is accomplished as follows:

According to Hsu (2013), the power-law exponent, p, can be determined from the 5-second gust over 2 minute (sustained wind speed) period as used in wind speed measurements by the Automated Surface Observing System (ASOS) station at airport worldwide such that,

$$G = 1 + 2.04 P \qquad (7)$$

Where G is the gust factor (the ratio of 5-s gust to 2-min sustained wind speed) and p is the power-law exponent. Fig. 12 shows that since G = 1.3672 at Houston Hobby Airport, P = 0.180, indicating this location was between Categories II and III. Because there is no further classification, we need to produce the statistical relationships amongst roughness length, power-law exponent and the gradient height. On the basis of Table 1, these relationships are analyzed and presented in Figs. 13 through 15.

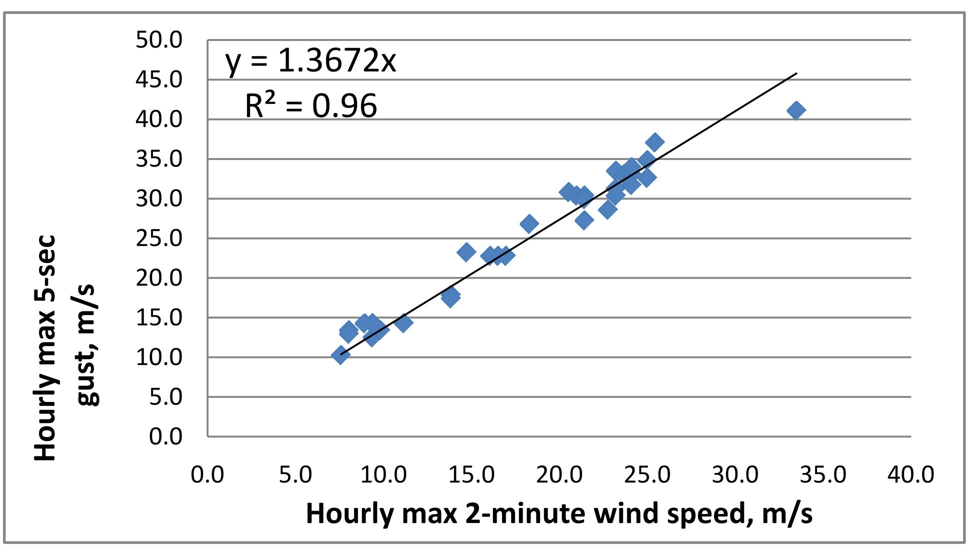


Figure 12 : Relationship between sustained wind speed and gust on 12-13 September 2008 in Houston Hobby Airport during Hurricane Ike

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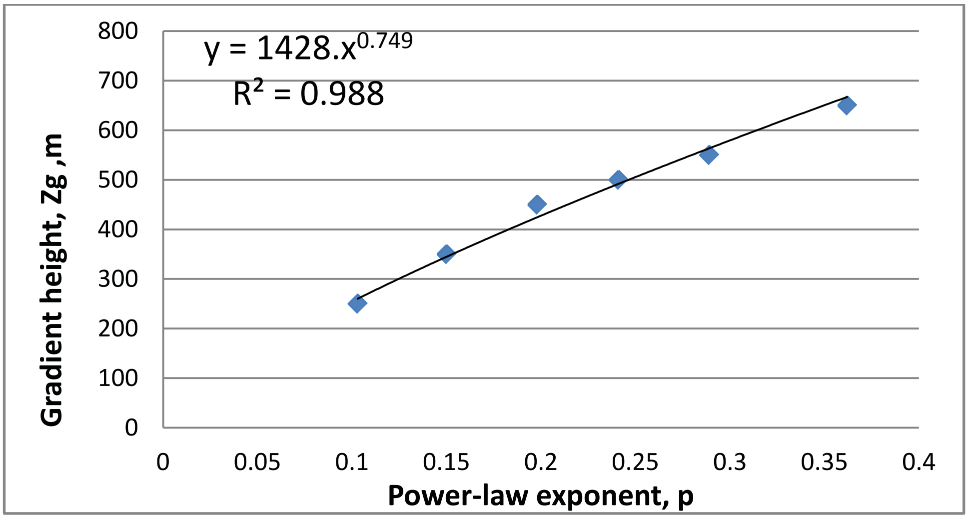
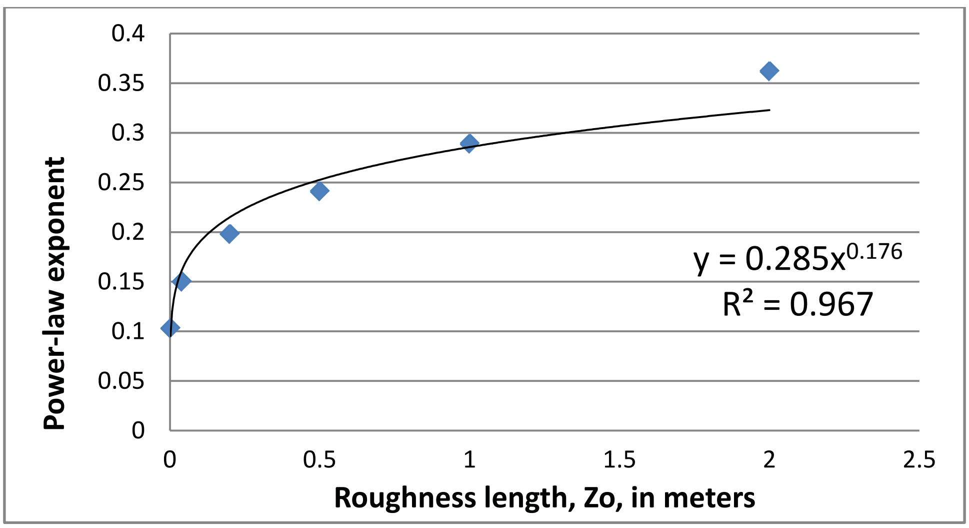


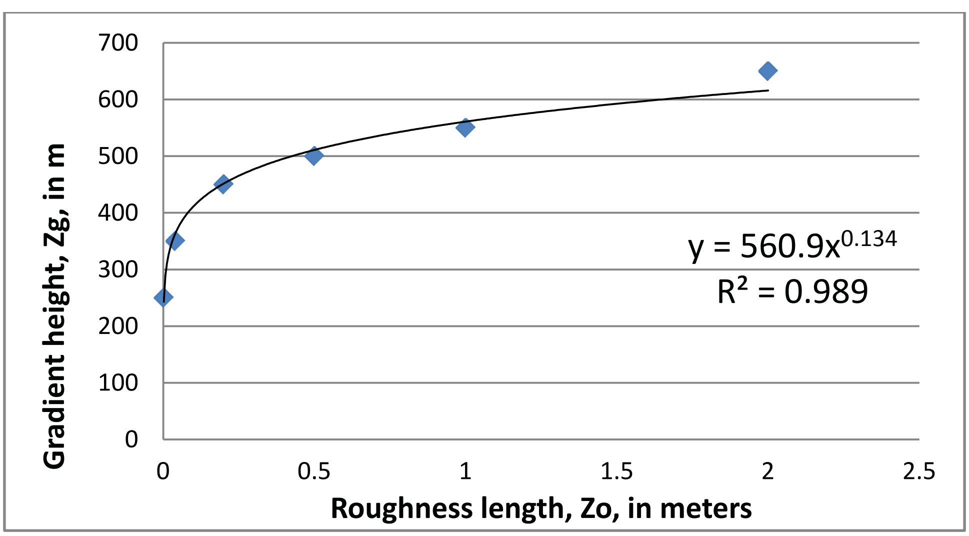
(Data Source : Choi, 2009)

Figure 13 : Relationship between the gradient height and power-law exponent



(Data Source : Choi, 2009)

Figure 14 : Relationship between roughness length and power-law exponent



(Data Source : Choi, 2009)

Figure 15 : Relationship between roughness length and gradient height

With these methods we can compute the wind speeds at the two heights on the Houston tower as follows:

- Based on Fig. 13, given p = 0.180 for Houston Hobby Airport, the gradient height is estimated to be 395 m;
- From Fig. 12, the max sustained 2-min wind speed over Hobby was approximately 34 m/s. Therefore the wind speed at the gradient height of 395 m over Hobby Airport is

$$U_{395m} = U_{10m} *(395/10) \wedge 0.18 = 34 * 1.94 = 66 \text{ m/s},$$

According to Schade (2007), the mean turbulence intensity was 0.29 for the tower. According to Hsu (2013), the power-law exponent, p, is numerically equal to the turbulence intensity. We can assign p = 0.29 for this tower location. Thus, from Fig. 13, the gradient height over the tower is 565 m. Now, we can now compute the wind speed at 60 m at the tower to be

$$U_{60m} = U_{565m} *(60/565) \wedge 0.29 = 66 * 0.52 = 34 \text{ m/s}.$$

Similarly, the wind speed at 20 m on the tower is computed as

$$U_{20m} = U_{565m} *(20/565) \wedge 0.29 = 66 * 0.38 = 25 \text{ m/s}.$$

A comparison of these estimations against the measurements is presented in Table 4. It is found that the agreement is excellent, indicating that our methodology as provided above is operational.

Table 4 : A comparison of wind speed at 2 levels during Hurricane Ike in 2008

Height, m	Estimated wind Speed, m/s	Measured wind Speed, m/s	Difference In per cent
60	34	33	3%
20	25	25	0%

V. An Evaluation using mean Building Height as Input

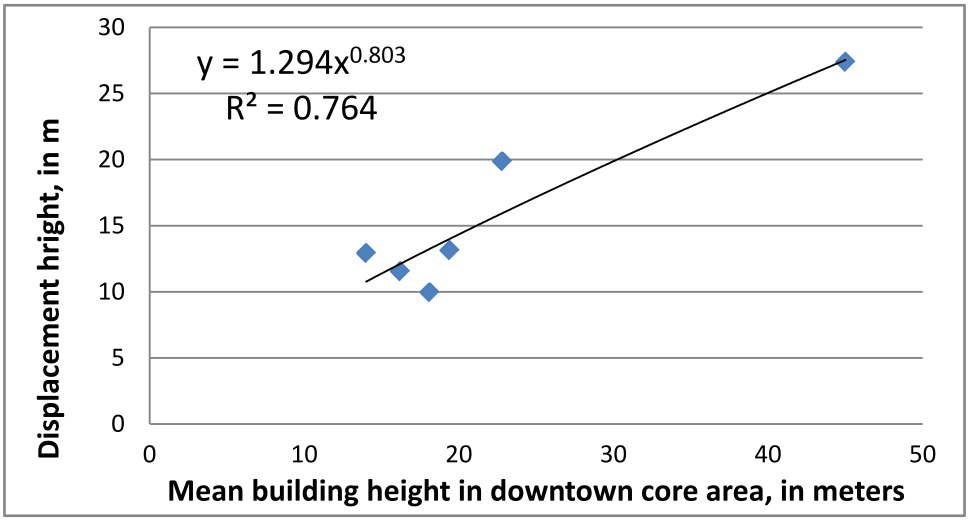
As stated above, the construction of few super tall buildings (building height > 300 m) in several cities makes the estimation of displacement difficult. However, for many urban areas, it is still useful to employ the mean building height as an input to estimate the displacement height. This is done as follows:

- According to the data as provided in Burian et al (2005), which is listed in Table 5, we can say that the displacement height is approximately 72 per cent of the mean building height in the downtown core areas in the cities as studied. This value is reasonably close to that of 80 % as suggested by Panofsky and Dutton (1984, P.376), since the difference is about 10 %.

Table 5 : Data for the displacement height and mean building height in several cities in USA (Data source: Burian et al, 2005)

City	Mean building Height in Downtown, m	Displacement Height, d, m	Ratio
Los Angeles	45	27.38	0.61
Houston	22.8	19.87	0.87
Oklahoma City	19.4	13.14	0.68
Albuquerque	14	12.93	0.92
Phoenix	16.2	11.55	0.71
Portland	18.1	9.97	0.55
		mean	0.72

- Using Table 5, we can now analyze and plot the relationship between the mean building height and the displacement height. Since there are only 6 cities, this R 2 = 0.76 is considered to be useful as a first approximation. This is needed since there are many cities in the hurricane or typhoon prone areas, which does not have the survey of the displacement height as those shown in Table 5, but the mean building heights in many downtown areas are known as published in the National Building Statistics Database: Version 2 by the Los Alamos National Laboratory (Publication Number LA-UR-08-1921).



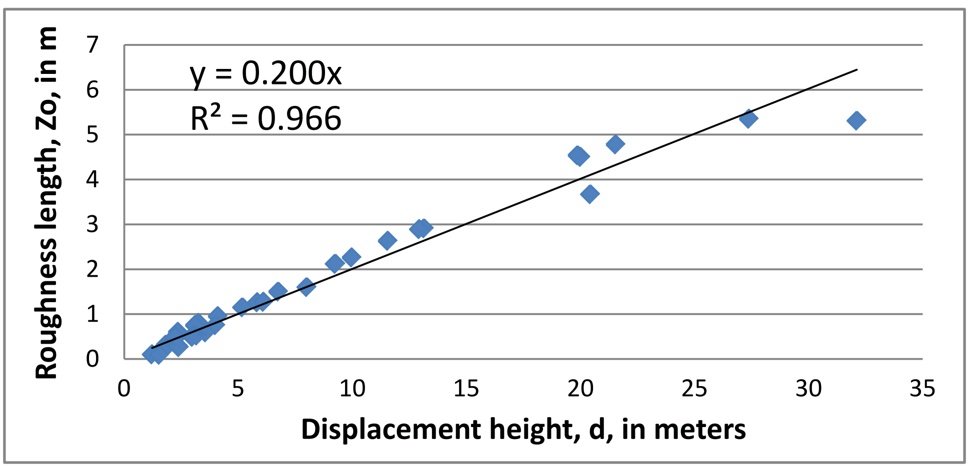
(Data Source : Burian et al., 2005)

Figure 16 : Relationship between mean building height and displacement height

- Because Table 1 requires the value of roughness length, Zo, we further acquire and analyze the datasets including both Zo and the displacement height in more cities. The results are presented in Table 17, which indicates that

$$Zo = 0.2\ d \tag{8}$$

Since the coefficient of determination, R^2 =0.97, is very high, Eq. (8) should be useful operationally.



(Data Source : Burian et al., 2005)

Figure 17 : Relationship between displacement height and routhness length

VI. An Evaluation using Typhoon Sally in 1996 over Hong Kong and Shenzhen, China

Full-scale monitoring of typhoon effects on super tall buildings was conducted during the passage of Typhoon Sally in 1996 (see Li et al., 2005). For our evaluation, we employ the measurements at Cheung Chau. From the position provided in Li et al (2005), this station is located in Category I. According to Hsu (1988, p. 202), P = 0.10 and Hsu (1988, pp. 126-127), the gradient height = 250 m. These values are in excellent agreement with Category I as listed in Table 1.

Further verification of the gradient height over Hong Kong City is presented in Figures 18 and 19, which show the distinct characteristics of two layer flow with the separation elevation located at 694 m in both wind speed (Fig. 18) and direction (Fig.19). Since the difference between this measured value of 694 m and the proposed value of 650 m is approximate 6 percent, we may use the proposed value as a first approximation.

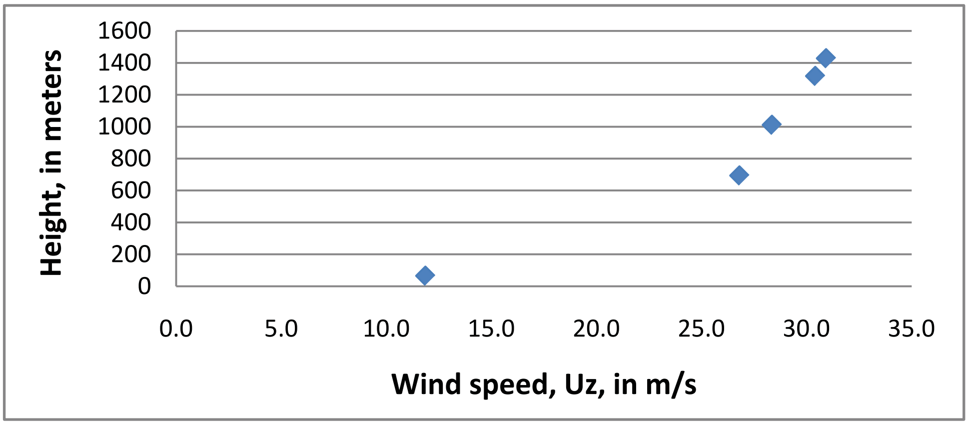


Figure 18 : Variation of wind speed with height at 18Z on 08 September 1996 based on Hong Kong Observatory during Typhoon Sally

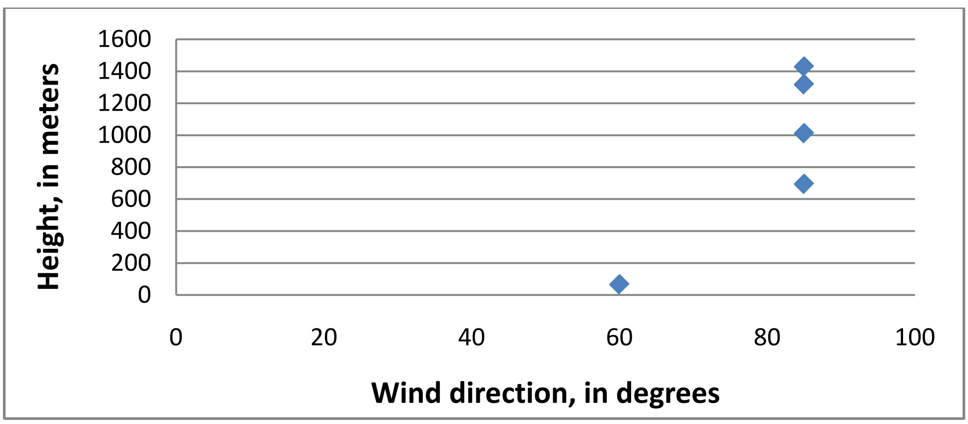


Figure 19 : Variation of wind direction with height at 18Z on 08 September 1996 based on Hong Kong Observatory during Typhoon Sally

With the aforementioned verification of the gradient height in mind, we can now comparethe wind speed measurements atop the tall buildingand the wind speed estimates from Table 1 in Hong Kong.

First, on the basis of the measured max wind speed of 37.5 m/s at 92 m at Cheung Chau, the wind speed at 250 m over that station (Cat. I) is

$$U_{250m} = U_{92m} * (250/92) \wedge 0.103 = 37.5 * 1.11 = 41.6 \text{ m/s}.$$

This max speed is expected to be the same at U650m over Hong Kong and Shenzhen so that the max wind speeds atop of the Central Plaza Tower at 374 m in Hong Kong and Di Wang Tower at 384 m in Shenzhen are estimated from Table 1 for Cat. VI as

$$U_{374m} = U_{650m} * (374/650) \wedge 0.362 = 41.6 * 0.82 = 34.1 \text{ m/s, and}$$

$$U_{384m} = U_{650m} * (384/650) \wedge 0.362 = 41.6 * 0.83 = 34.5 \text{ m/s,}$$

respectively. These results are compared with measurements as shown in Table 6.

Table 6 : A comparison of max wind speed between estimated and measured atop tall buildings during Typhoon Sally in 1996

Tall Building	Height, m	Estimated max speed, this study, m/s	Measured, see Li et al (2005), m/s	Difference in percent
Central Plaza Tower in Hong Kong	374	34.1	29.6	13 %
Di Wang Tower in Shenzhen	384	34.5	33.5	3 %

Since the average difference is (0.13 + 0.03)/2 = 0.08 or 8 %, which is within 10 % for the composite margin of error for wind speed measurements, it is reasonable to say that Table 1 is evaluated to be useful operationally.

VII. Conclusions

A proposal based on Choi in 2009 for "unified terrain categories exposures and velocity profiles" has been evaluated extensively in this study. This evaluation includes 3 separate papers published most recently under the conditions of Typhoon Muifa in 2011 over the greater Shanghai, China, region, one study during Hurricane Ike in 2008 over Houston, Texas, USA, one paper for super tall buildings (> 300m) during Typhoon Sally in 1996 over Hong Kong and Shenzhen, China and one study during an atmospheric dispersion experiment in New York City, USA. In addition, in order to support the evaluation of gradient height, upper-air sounding measurements are acquired and analyzed when appropriate. On the basis of these evaluations, it is found that the criteria as shown in Table 1 are useful operationally for engineering applications except the designation of the displacement height which requires further investigation. An alternative approach using the mean building height as the input for the power-law exponent is proposed.

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Minimization of Spent Acid Waste from Galvanizing Plant in Malaysia

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Abstract - Hydrochloric acid is used as pickling acid in galvanizing industry to remove rust from steel. Usage of this acid incurs high expenditure cost when it is disposed as scheduled waste. The importance of this study is to come up with a better way to minimize the cost being spent for hydrochloric acid disposal by optimizing and extending the life span of the hydrochloric acid. The methodology used in this project is by conducting experiment of regeneration of Hydrochloric acid using Kleingarn acid management system, collecting experiment data and calculating the short and long term cost reduction that can be achieved. The results obtained through experimentation shows that acid purchase time has been successfully extended; which in return helps to reduce the fresh hydrochloric acid purchase frequency. Implementation of Kleingarn acid management system helped the acid dumping frequency to be extended. This is a positive result because extension of the acid disposal time also means that lesser spent acid waste are being produced and lesser hazardous waste will be disposed in the future.

Keywords : galvanizing, hydrochloric acid, kleingarn acid management system.

GJRE-E Classification : FOR Code: 090599

MINIMIZATIONOFSPENTACIDWASTEFROMGALVANIZINGPLANTINMALAYSIA

Strictly as per the compliance and regulations of :

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Nalienaa Muthu [α] , Faieza Abdul Aziz [σ] & Profesor Dr. Rosnah Binti Mohd Yusuff [ρ]

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I. Introduction

Corrosion is a natural process of degradation caused by chemical reaction between steel which comes in contact with the environment or abrasive effects between steel and other material. Rusting is the most common and economically destructive form of corrosion. Potential damage that can be caused by corrosion is degradation of structures, machines, and containers. There are many approaches to protect steel from corrosion which can indirectly avoid damages caused by corrosion (Sastri, 2007).

Hot dip galvanizing process prevents corrosion of steel by providing a tough, durable barrier coating of metallic zinc which completely seals the steel from corrosive environment (Chandler, 1985). One of the main steps involved in galvanizing process would be removal of rust from the steel using pickling acid. In this project, the pickling acid used is hydrochloric acid because it is more economical and less hazardous. The fresh hydrochloric acid which is bought at certain price need to be disposed as scheduled waste which cost even more than the purchasing price of fresh hydrochloric acid.

The importance of this study is to come up with a better way to minimize the cost being spent for hydrochloric acid disposal. This project uses application of the Kleingarn acid management system to minimize wastage of hydrochloric acid in galvanizing process through optimization of hydrochloric acid. Hydrochloric acid is optimized by recovering the acid value and extending the life span of the hydrochloric acid. Extension of the acids life span helps in reducing the frequency of acid disposal, which in return helps in reducing the cost being spent for hydrochloric acid disposal.

Once the strength of hydrochloric acid has been reduced, the hydrochloric acid cannot be reused, it needs to be disposed as schedule waste whereby the disposal cost happens to be more than the initial acid purchase price (McClay, 2007). There are many methods in disposing spent acid wastes, such as containing it in drums and selling it to vendors and disposing the spent acid waste in dedicated waste disposal landfill (Patnaik, 2007).

The main problem that the project concentrates on is minimization of spent acid waste in galvanizing industry. Galvanizing companies are facing the high expenditure cost spent in disposing the hydrochloric acid as scheduled waste. Once the strength of hydrochloric acid has been reduced, the hydrochloric acid cannot be reused and it becomes spent acid. This spent acid needs to be disposed as schedule waste whereby the disposal cost happens to be more than the initial acid purchase price. McClay, (2007); Fresner, (2006) and Steward, (1995) were facing the same problems that the company in galvanizing industry is facing which is the high expenditure cost spent in disposing the hydrochloric acid as scheduled waste.

This study is being conducted to propose an improved waste management system for hydrochloric acid and it can also act as a cost reduction project. The main objectives of this project are to identify feasible method for disposing hydrochloric acid as scheduled waste in a galvanizing company and to implement the Kleingarn acid management system method and test the effectiveness in reducing the waste.

II. Hot Dip Galvanizing

The main purpose of galvanizing is to provide a protective coating to steel so that corrosion does not

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take place. Rusting is the most common and economically destructive form of corrosion (The Effects and Economic Impact of Corrosion, 2000). The process of galvanizing steel with zinc layer helps to form a barrier between steel and other corrosive elements, preventing it from corrosion which can cause dangerous damage. The galvanized steel coating of zinc also has excellent abrasion resistance (Hall, 1963). Hot-dip galvanizing is a form of galvanization. It is the process of coating iron, steel or aluminum with a thin zinc layer, by passing the metal through a molten bath of zinc at a temperature of around 450 °C (Hall, 1963). When exposed to the atmosphere, the pure zinc (Zn) reacts with oxygen (O_2) to form zinc oxide (ZnO), which further reacts with carbon dioxide (CO_2) to form zinc carbonate ($ZnCO_3$) (Volovitch, 2011).

Hot dip Galvanizing process can only be carried out in a galvanizing company and a galvanized material is only available in one color (Graham, 1970). The physical appearance of galvanized steel may vary from one galvanizing company to another due to the difference in additives used in their zinc kettle. However, the physical appearance does not change the initial functionality of galvanized zinc coating, which is to prevent steel from corrosion.

a) Pickling using Hydrochloric Acid

According to Tang (2012), every hot dip galvanizing process involves the steps of preparation and arrangement of untreated steel products, degreasing the steel, cleansing the steel, pickling, washing and cleansing the acid from steel, Pre-Fluxi chemical dipping, Molten Zinc dipping and at last there is the inspection step. Among these steps, the pickling process plays an important role in pre-treatment of the steel surface prior to chemical dipping and molten zinc dipping.

Tang (2012) also mentioned that the pickling process is a chemical procedure where the steel is dipped into a tank that contains one of these four acids, namely the sulfuric, nitric, hydrochloric or phosphoric acid solution. Although all of these strong acids can be used as pickling acid, hydrochloric acid is the much preferred acid for pickling process.

During the pickling process, any kind of impurities such as stains, inorganic contamination, rust, surface oxides and other contaminations are removed by a chemical reaction of the surface and the pickling solution. The final result of this pickling process would be that all layers of impurities dissolves as ions into the acid solution (Kittisupakorn, 2005).

The sulfuric, nitric, hydrochloric or phosphoric acid solution can be used for pickling process. Sulfuric acid was widely used by galvanizing companies for a long period of time, however, in recent years sulfuric acid has been replaced by hydrochloric acid for pickling process (Tang, 2012).

Although purchasing hydrochloric acid is more expensive compared to purchasing sulfuric acid, but hydrochloric acid tends to be a more preferred type of acid to be used for pickling process due to its waste disposal cost which is cheaper compared to disposing sulfuric acid as scheduled waste. Phosphoric acid is overall more expensive compared to both these acids (Chandler, 1985). Throughout this project, the focus will be on hydrochloric acid which is a commonly used acid in hot dip galvanizing companies in Malaysia for the surface treatment of steel products.

There are many advantages in using hydrochloric acid for pickling process compared with sulfuric acid. These advantages have been discussed by Tang (2012) and in (Surface Preparation of Structural Steel-Part 2 Communication from the Stichting Nederlands Corrosie Centrum). Hydrochloric acid is considered to be the better acid to allow faster cleaning rate at normal temperatures compared to other acids used for pickling process.

The galvanizers can attain better quality of galvanized product with complete coating and without visible patches by subjecting their products through the pickling process. Although this is just for visual enhancement, but materials that are not subjected to pickling will not look as attractive as the one that are subjected to pickling process. A complete coating will determine the galvanized materials standard.

b) Hydrochloric Acid as Scheduled Waste

The pickling bath is used in hot dip galvanizing process to remove impurities from the surface of steel and produce a clean surface (McLay, 2007). The concentration level and the contamination level of the hydrochloric acid that is used for this process will change and once it reaches an unaccepted level, it need to be disposed or discarded by sending to licensed specialist treatment operators to be neutralized using alkaline waste. This waste product which needs to be disposed is referred to as spent pickle liquor or acid waste. Spent pickle liquor or acid waste is the main source of waste in hot dip galvanizing industry.

The corrosive nature and presence of residual acid as well as high metal content are other reasons why spent pickling liquors are considered as hazardous wastes. Treatment of hazardous wastes involves costs and it's a job where regulations and certain rules need to be followed strictly. It cannot be taken for granted as the consequences can be very dangerous.

c) Methods for Regeneration of Hydrochloric Acid

Regeneration of spent pickling liquors is a process that involves reduction in the volume of hydrochloric acid wastes to be generated (Tang, 2012). Implementation of regeneration process or any type of a recovery process in hot dip galvanizing industry usually involve some extra investment and it is very important to ensure that skillful operators are deployed to handle the task so that the objective can be achieved. There are many regeneration methods available in galvanizing industry due to the interest shown by the industry owners to develop a better recovery process of waste acid.

i. *Pyrohydrolysis*

Agrawal (2009) have discussed on Pyrohydrolysis which is a process where the spent pickle liquor will be thermally decomposed in order to convert the spent pickle liquor back into hydrochloric acid and iron oxide. This process is carried out at a very high temperature plus with water vapor and oxygen. The spent pickle liquor is pumped into a pyrohydrolysers which will convert the Fe_2Cl_2 into components of Fe_3O and hydrochloric acid.

Regeneration of hydrochloric acid using pyrohydrolysis method is usually considered by companies operating in very big scale because this method is considered to be costly, due to the high energy cost involved in the installation and operation of pyrohydrolysers. This method is not environmental friendly due to the corrosive chloride and fluoride salts that exist in the dust emitted by this process. As such, any company that would like to install this system will also need to install dust collection system which will incur more cost (Agrawal, 2009).

ii. *Crystallization*

According to Brown (2006), initially, regene-ration using crystallization method was used for regeneration of waste sulphuric acid. However, in the long run, regeneration using crystallization was also able to be performed for hydrochloric acid waste. The applicability of regeneration using crystallization for hydrochloric acid have been confirmed upon conducting some technical feasibility tests. It was also concluded that multi-stage crystal-lization need to be conducted in a series of CSTR-type crystallizers. The hydrochloric acid waste also needs to go through crystal recycling process in order to yield impurity-free.

This regeneration process via crystallization of ferrous sulphate, which involves a standard technique, does not have a size limitation. The newly regenerated hydrochloric acid might have some impact on the pickling process due to the dead-load of sulfate. This problem can be eliminated by adjusting the conditions of pickling rates to be at least equal to pure hydrochloric acid with an acceptable surface finish. (Magdalena, 2010 and Brown, 2006).

iii. *Hydrolytic Precipitation*

Based on George (2008), the regeneration of hydrochloric spent pickling liquors using hydrolytic precipitation method involves the process of vapor distillation under evapora¬tive hydrolysis conditions at temperatures as high as 250°C. When there are no other chloride salts present, hydrolytic distillation process proceeds to completion at around 175°C. However, when Magnesium chloride is present, a higher temperature is required for the hydrolytic distillation process be completed.

iv. *Solvent Extraction Route*

The solvent extraction route method is a popular regeneration method. This regeneration method is preferred because it produces less hazardous by-products in the process of treating spent pickling liquors. By using the solvent extraction route method $FeCl_2$ and $ZnCl_2$ can be separated from hydrochloric acid. This process can be a little costly compared to the normal disposal of spent pickling liquors. Since this method requires waste water treatment which not all galvanizing company gives priority to, it can incur more cost. The byproduct produced from the regeneration of hydrochloric spent pickling liquors need to go through post-treatment before it can be discarded (Kerney, 1994).

v. *Kleingarn Acid Management System*

By adopting this regeneration method, the costs of replacement of the spent pickling liquors with new could be reduced. This method needs less initial investment. Application of Kleingarn acid management system as regeneration method in hot dip galvanizing company helps in reducing waste volume by saving the amount of hydrochloric acid being used. This regeneration method also may ease the recycling of acid wastes (Stocks, 2005).

Kleingarn acid management system needs less initial investment and at the same time it helps in reducing spent pickling liquors volume. Regeneration of spent pickling liquor using Kleingarn acid management system can assist in increasing the acid strength and reducing the iron concentration at the same time. Experiments need to be carried out in order to obtain the optimum pickle rate using this regeneration method. This regeneration process can be repeated until the dedicated hydrochloric acid bath tank needs to be emptied for cleaning or repair. Once the dedicated hydrochloric acid bath tank is emptied, fresh solution should be made up using partly spent acid from other tanks plus fresh acid. The regeneration of hydrochloric acid using Kleingarn acid management system has many efficient and ecological advantages.

III. Materials and Methods

The problem was identified as need for reduction of the extra cost spent on hydrochloric acid disposal by optimising the hydrochloric acid usage. Project proceeds with the site visit at the galvanizing company to enable to see the overall process including the problem area and to ensure the understanding on the overall process flow. Focus was on the current hydrochloric acid pickling process and the hydrochloric acid waste disposal process. Specifically four methods were proposed to the galvanizing company to decide on

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applicability upon completion of literature review. After a brief discussion on the most appropriate method that can be applied for regeneration of hydrochloric acid, Kleingarn acid management system was chosen.

This experiment is conducted on one dedicated hydrochloric acid tank. This dedicated tank was used throughout the project experimentation. Next step would be conducting experiment of regeneration of Hydrochloric acid using Kleingarn acid management system to reduce the spent acid waste. The sample size of acid is taken on weekly basis in order to get the hydrochloric acid strength level and to determine the level of iron present in the dedicated tank.

Once the acid sample is taken from the dedicated hydrochloric acid tank, it is sent to the lab in the galvanizing company to test the hydrochloric acid strength level and iron level. This is done to confirm that the hydrochloric acid level and iron level are within the range set by the company. Once it is confirmed that the hydrochloric acid level and iron level are within the range set by the company, project goes ahead and continue with pickling process.

Once the hydrochloric acid strength and the iron content level is tested and found to be within the intended range which is set by the company the galvanizing process will follow the existing process flow. The pickling process will resume as usual. In this case, the pickled product is rinsed in the tank containing water and goes on to zinc bath and finally it is subjected to inspection.

However, if the hydrochloric acid level and iron level are not within the range set by the company, the regeneration of Hydrochloric acid methodology is applied. Fresh hydrochloric acid is added into the dedicated hydrochloric acid tank in order to increase the hydrochloric acid level and reduce the iron level. The amount of fresh hydrochloric acid to be added is determined using the equation as per Kleingarn acid management calculation.

Upon adding the amount of fresh hydrochloric acid, the new acid sample is taken from the dedicated hydrochloric acid tank and sent to the lab in the galvanizing company once again to test the new hydrochloric acid strength level and iron level. This is done to reconfirm that the hydrochloric acid level and iron level are within the range set by the company after adding in fresh hydrochloric acid.

This step is followed by collection of experiment data to validate the reduction rate of spent acid waste. The short and long term cost reductions are calculated by tabulating the experiment data collected for 20 weeks. The experiment data and calculation of cost reduction is being used to answer the second objective of this project which is to test the effectiveness of the chosen method for regeneration of hydrochloric acid.

IV. Results and Discussion

The regeneration of hydrochloric acid using Kleingarn acid management system was considered to be more feasible and practical method to be applied for disposing hydrochloric acid as scheduled waste in galvanizing company. This is because this method is conducted by topping up the existing hydrochloric acid with fresh hydrochloric acid based on the iron and chloride level. The lab testing to obtain the experiment results incur minimum cost.

a) The Experiment

This experiment was conducted using hydrochloric acid as the main chemical for steel pickling process. The experiment was conducted for a period of 20 weeks and the sample size of acid was taken on weekly basis. The lab facility in the galvanizing company was utilized to test the hydrochloric acid strength level and to determine the level of iron present in the spent acid waste.

i. *Hydrochloric Acid Bath Tank and Hydrochloric Acid*

Firstly, a dedicated hydrochloric acid bath tank was set up. The dedicated acid bath tank functions as per normal in the sense where it was fully utilized for production. The size of the acid bath tank is 6 meters length, 1.6 meters width and 2.0 meters height.

The fresh hydrochloric acid that is bought by the company from their vendor is at 34% concentration level. Hydrochloric acid is a strong acid with low PH value; as such the hydrochloric acid cannot be poured into the acid bath tank directly at the concentration level of 34%. The acid bath tank is made of steel and lined with fiber glass, so, using the hydrochloric acid at this level will cause damage to the tank by corroding it due to the hydrochloric acids high level of corrosiveness (Davis, 2000).

That is the reason why the hydrochloric acid is diluted from 34% of acid concentration to 16% of acid concentration. During the dilution process, the acid will be added into water contained in the acid bath tank instead of adding the water into the concentrated hydrochloric acid. This is done in this manner because adding water into concentrated hydrochloric acid can cause strong reaction and may cause acid splash which can be dangerous to the worker who is handling the dilution process (Olmsted, 1997).

Although the acid bath tanks height is 2.0 meter, but the hydrochloric acid solution will not be filled at the height of 2.0 meter. This is because, the hydrochloric acid solution in the acid bath tank needs some room to raise once the steel that needs to be pickled is immersed into the acid bath tank. This is the reason why the total amount of hydrochloric acid diluted in water is set to be at the height of 1.6 meter in the acid bath tank instead of the actual height of the acid bath tank which is 2.0 meter.

ii. *Pickling Process*

Iron should be present in the acid bath tank in order to help kick off the pickling process and to make the pickling process perform faster. Diluting the hydrochloric acid using the water taken from rinsing tank where there is iron present will help to expedite the pickling process. The optimum level of iron and hydrochloric acid need to be maintained because in case the solubility limit of iron in hydrochloric acid is exceeded then pickling will not take place.

When the pickling process takes place, the iron concentration of the pickle solution will increase in the acid bath tank as the acid strength decreases. Once the iron concentration increases out of the range due to pickling process, the spent pickle solution may be regenerated by the removal of a quantity of the spent acid and the addition of fresh acid.

iii. *Data Collection*

The hydrochloric acid sample to be tested which is taken from the dedicated acid bath tank is collected on weekly basis. The specific day to collect the sample was set to be every Wednesday. The reason behind this setting is because the hydrochloric acid strength reductions will not be significant if the sample is taken on daily basis. Taking the sample once a week gives the hydrochloric acid tank sufficient exposure to zinc and other materials due to the continues production for a period of one week. Another reason for taking the sampling in the mid of a week is because by doing the sampling on every Wednesday, the lab testing results can be obtained by the end of the day or latest by the next day which is Thursday and the project can determine the acidic level of the hydrochloric acid in the dedicated tank to decide on the addition of fresh acid. The experiment results have been tabulated into table form and presented below in table 1.

Table 1 : Experiment results

HCL TANK 1					
CHEMICALS	HCL (g/L)	Iron (g/L)	Addition Fresh HCL (tonnes)	New level of Hydrochloric acid upon top up (g/L)	New level of iron upon top up (g/L)
Range	90 – 140	60 - 90		90 – 140	60 – 90
MAX	140	90		140	90
MIN	90	60		90	60
Week					
1	135.00	78.00			
2	**86.00**	**93.00**	3.73	132.00	78.71
3	118.00	78.00			
4	**75.00**	**91.00**	4.11	128.00	77.02
5	129.00	78.00			
6	**83.00**	**94.00**	3.84	134.00	79.56
7	**80.00**	**98.00**	3.94	126.00	82.94
8	123.00	78.00			
9	**83.00**	**92.00**	3.84	127.00	77.86
10	98.00	78.00			
11	**87.00**	**91.00**	3.69	131.00	77.02
12	121.00	78.00			
13	96.00	78.00			
14	**79.00**	**95.00**	3.97	133.00	80.40
15	103.00	78.00			
16	**88.00**	**92.00**	3.66	126.00	77.86
17	104.00	78.00			
18	94.00	78.00			
19	**84.00**	**99.00**	3.80	134.00	83.79
20	**85.00**	**91.00**	3.76	125.00	77.02

iv. *Results with Acceptable Range of Hydrochloric Acid Strength*

For this project the hydrochloric acid level was maintained at the range of 9% to 14% under normal condition with iron present in the acid bath tank. The iron content level was maintained at the range of 6% to 9% (Hornsby, 1995).

Theoretically the hydrochloric acid solution in the acid bath tank was calculated to achieve 16% of hydrochloric acid concentration; however, the lab test result confirmed that the hydrochloric acid strength was at 13.5% with iron present and the iron content was at 7.8% as per the lab test result noted in week 1.

This is because distilled water was not used, whereas rinsing water which already contains certain level of iron chloride was used in the process for diluting the hydrochloric acid. Rinsing water is the water in the tank where the metal which has already gone through pickling process will be rinsed in. Since hydrochloric acid is corrosive, it tends to least corrode the metal immersed in it during pickling process.

Once the pickled metal is dipped into the rinsing tank for washing the metal, elimination process of pickling reaction products takes place. Example of the pickling reaction products are namely iron salts and iron oxides. These pickling reaction products will be stacking in the rinsing water tank (Taylor, 2002).

In week 1, the fresh hydrochloric acid was not added to the acid bath tank because both the hydrochloric acid strength and iron content were within the intended range.

Once both the hydrochloric acid strength and the iron content are out of the intended range, the pickle solution needs to be regenerated. This is done by removing a volume of the spent pickle solution and adding it with an equivalent volume of fresh 34% of hydrochloric acid in order to produce a pickle solution with strength of 9% to 14% and iron content at the range of 6% to 9%.

v. *Results with Low Hydrochloric Acid Strength*

Referring to the data obtained from the chemical lab test at week 2, the hydrochloric acid strength and the iron content showed 8.6% and 9.3% each. This value is out of the acceptable range, where the hydrochloric acid strength needs to be within 9% to 14% and iron content needs to be at the range of 6% to 9%.

Since the lab test data shows that the hydrochloric acid strength and the iron content are out of the intended range, certain quantity of pickled acid needs to be removed from the dedicated acid bath tank and replaced with fresh hydrochloric acid at the concentration of 34% to retain the hydrochloric acid strength and to enable the pickling process to take place at normal rate.

Refer to the calculation below for determining the volume of spent pickle solution to be removed and the iron concentration of the regenerated spent pickle waste:

Volume spent pickle solution = 6m × 1.6m × 1.6m

Volume spent pickle solution = 15.36 m ^3

Volume regenerated acid = 6m × 1.6m × 1.6m

Volume regenerated acid = 15.36 m ^3

Concentration of spent pickle solution = 8.6%

Concentration of fresh acid = 34%

Concentration of regenerated acid = 16%

The volume of spent pickle waste to be removed, r according to Eq. 1:

$$r = [(\text{Concentration of regenerated acid} \times \text{Volume regenerated acid}) - (\text{Concentration of spent pickle solution} \times \text{Volume regenerated acid})] \div (\text{Concentration of fresh ac} \qquad (1)$$

$$r = [(16\% \times 15.36m^3) - (8.6\% \times 15.36m^3)] \div (34\% - 8.6\%)$$

$$r = 4.475\ m^3 \div 1.2$$

$$r = 3.73 \text{ tonne}$$

To achieve a regenerated solution with a concentration of 16% of hydrochloric acid, 3.73 tonnes of spent pickle waste need to be removed from the acid bath tank and toped up with 3.73 tonnes of fresh 34% of hydrochloric acid. The amount of spent pickle waste that needs to be removed varies from week to week. The average amount of spent acid waste to be removed and topped up is 3.834 tonnes per week. The topping up process did not occur very often. There were weeks when fresh acid top up was not required as in week 1. The iron concentration of the regenerated spent pickle solution; z can be calculated using Eq. 2:

Volume of remaining pickle solution will be $= 15.36m^3 - 4.475m^3 = 10.885m^3$

$$z = (\text{Iron concentration of spent pickle solution} \times \text{Volume of remaining spent pickle solution}) + (\text{Iron concentration of fresh acid} \times \text{Volume of fresh acid})] \div \text{Volume of regenerated solution} \qquad (2)$$

$$z = [(90 \times 10.885) + (0 \times 4.475)] \div 15.36$$

$$z = 63.78$$

The newly regenerated solution should contain 63.78 gram/liter of iron. The new regenerated spent acid waste solution therefore should contain 16% of hydrochloric acid strength and about 63.78 gram/liter of iron. These figures are based on the theoretical calculation. The hydrochloric acid strength and iron content in actual galvanizing industry varies due to the presence of other components in the acid bath tank such as iron chloride.

Upon subjecting the regenerated pickle solution to lab test, it was found that the new regenerated spent acid waste contains 13.2% of hydrochloric acid concentration and about 78.71 gram/liter of iron content. Although there are some differences in the theoretical value compared to the actual value, the hydrochloric acid strength and iron content are still within the intended range.

It was also observed during the experimentation that whenever the acid concentration in the hydrochloric acid tank decreases, the iron content will increase. This experiment was started with hydrochloric acid strength at a high side then as the time passes by and production continues, the acid concentration reduces as it converts iron oxides to iron chloride (Peter Maa, 2011). From the experiment data, it can be noticed that the fresh acid top up process is not done on weekly basis. In average the top up process is done every alternate week.

vi. *Waste Minimization*

The experiment results can be divided into five months. Table 2 displays the comparison between hydrochloric acid usage before and after implementing regeneration of spent acid waste using Kleingarn acid management system.

Table 2 : Comparison of hydrochloric acid usage before and after implementing regeneration of spent acid waste using Kleingarn acid management system

Top up per month (consist of 4 weeks)	Usage of hydrochloric acid upon implementing Kleingarn acid management system (tonnes)	Usage of hydrochloric acid by using traditional method (tonnes)	Savings (tonnes)
Month 1	7.84	12.00	4.16
Month 2	7.78	12.00	4.22
Month 3	7.53	12.00	4.47
Month 4	7.63	12.00	4.37
Month 5	7.56	12.00	4.44
Average	**7.67**	**12.00**	**4.33**

It is proven that prior to implementing Kleingarn acid management system, an average of 12.00 tonnes of hydrochloric acid is used in the pickling process. This data was taken by averaging the total amount of hydrochloric acid used for a period of 11 months. Whereas after implementation of Kleingarn acid management system, the average amount of hydrochloric acid used in a month has reduced to 7.67 tonnes.

By comparing the data obtained, we can witness that the project has achieved average savings of 4.33 tonnes of hydrochloric acid per month through implementation of Kleingarn acid management system. Although the fresh hydrochloric acid with 34% of concentration top up process involves some lab testing to be carried out, but the minimization rate of the hydrochloric acid used in a month proofs its worth.

vii. *Cost Calculation*

Average usage of 12 tonnes of fresh hydrochloric acid for 4 weeks is also equivalent to usage of 3 tonnes of fresh hydrochloric acid per week. Average usage rate of fresh hydrochloric acid through implementation of Kleingarn acid management system is 7.67 tonnes. Once the usage rate is divided into 4 weeks, it is equivalent to 1.9 tonnes per week. Table 3 shows summary of the cost calculation for hydrochloric acid disposal before and after implementing regeneration of acid using Kleingarn acid management system.

Table 3 : Cost calculation for hydrochloric acid disposal before and after implementing regeneration of acid using Kleingarn acid management system

For 20 weeks	Before regeneration method	After regeneration method
Volume of spent acid waste at RM625.00 per tone	12 tonnes per month	7.67 tonnes per month
Treatment time	5 – 10 mins	15 mins
Spent acid waste dump Frequency in weeks	6 weeks once for every 18 tonne	9.5 weeks once for every 18 tonne
Steel Pickled (according to plant capacity)	1000 tonnes	1000 tonnes

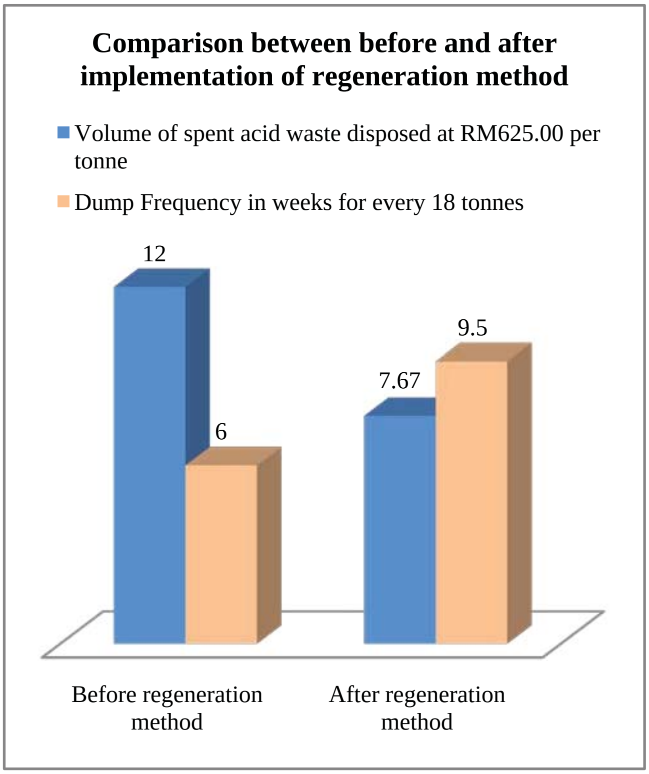
Note : 1 tonne = 1000kgs

Currently 18 tonnes of hydrochloric acid is being bought every 6 weeks once to be used as the pickling acid. However, upon implementing the Kleingarn acid management system, 18 tonnes of acid can be bought every 9.5 weeks once. By implementing this regeneration method, the acid purchase time have been extended from 6weeks to 9.5 weeks. As such, the fresh hydrochloric acid with 34% concentration's purchase frequency is reduced because the usage time is extended.

The amount of steel pickled in both cases is maintained at 1000 tonnes so that the comparison will be fair and not affected by any external factors. Disposal of spent acid waste is carried out every 9.5 weeks once for 18 tonnes of acid after implementation of regeneration method.

Implementation of regeneration using Kleingarn acid management system also helps to extend the hydrochloric acid dumping frequency. The hydrochloric acid dumping frequency has been extended from 6 weeks once for every 18 tonnes of spent acid waste to 9.5 weeks once for every 18 tonnes of spent acid waste.

Although the acid dumping frequency has only been extended for 3.5 weeks, in the long run, this value will contribute to a large amount of savings to the environment. This extension is healthy for the environment as lesser hazardous waste will be disposed in the future. Figure 1 helps to illustrate the comparison of volume of spent acid waste and spent acid waste dumping frequency before and after implementing regeneration of spent acid waste using Kleingarn acid management system



V. Conclusion

The effectiveness of the Kleingarn acid management system in reducing the scheduled waste was proven by extending the acid purchase time and by calculating the savings in monetary value. This project can be used by galvanizing company as a guidance in the process of scheduled waste minimization. Implementation of Kleingarn acid management system has helped to extend the existing acid purchase time from current duration of 6 weeks to a new extended duration of 9.5 weeks. Once the acid purchase time has been extended, the fresh hydrochloric acid purchase frequency can be reduced.

The amount spent for hydrochloric acid disposal as spent acid waste before implementation of regeneration using Kleingarn acid management system came up to RM7500.00 per month. The amount spent for hydrochloric disposal after implementation of regeneration using Kleingarn acid management system came up to RM4750.00 per month. Savings of RM2750.00 per month was observed. This savings is possible for the galvanizing company that implements Kleingarn acid management system to treat their spent acid waste. Although this savings does not look like a large sum, but in the long run, it will save the galvanizing companies a huge chunk of their expense for hydrochloric acid disposal as spent acid waste.

Once acid consumption is reduced, it automatically helps to extend the hydrochloric acid dumping frequency. By implementing Kleingarn acid management system, the acid dumping frequency has been extended from the original 6 week to extra 3.5 weeks. Extending the acid disposal time also means that lesser spent acid waste are being produced. This extension is healthy for the environment as lesser hazardous waste will be disposed in the future.

Application of the Kleingarn acid management system reduces waste volume, saves hydrochloric acid usage rate and increases the company's financial returns. The method used is simple, does not involve high costing and it is practical to be applied by any galvanizing company.

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Design Coefficients for Three Cell Box Culvert

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Abstract - Multiple cell reinforced box culverts are ideal bridge structure if the discharge in a drain crossing the road is large and if the bearing capacity of the soil is low as the single box culvert becomes uneconomical because of the higher thickness of the slab and walls. In such cases, more than one box can be constructed side- by- side monolithically.

The box culvert has to be analyzed for moments, shear forces and thrusts developed due to the various loading conditions by any classical methods such as moment distribution method, slope deflection method etc. It becomes very tedious for the designer to arrive at design forces for various loading conditions. Hence a study is made to arrive at the coefficients for moments, shear forces and axial thrusts for different loading cases and for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 for three cell box culvert.

This enables the designer to decide the combination of various loading cases to arrive at the maximum design forces at the critical section thus saving considerable design time and effort.

Keywords : design coefficients, three cell, culvert, moment, axial thrust, shear.

GJRE-E Classification : FOR Code: 290899

DESIGNCOEFFICIENTSFORTHREECELLBOXCULVERT

Strictly as per the compliance and regulations of :

Design Coefficients for Three Cell Box Culvert

Sujata Shreedhar [α] & R. Shreedhar [σ]

Abstract- Multiple cell reinforced box culverts are ideal bridge structure if the discharge in a drain crossing the road is large and if the bearing capacity of the soil is low as the single box culvert becomes uneconomical because of the higher thickness of the slab and walls. In such cases, more than one box can be constructed side- by- side monolithically.

The box culvert has to be analyzed for moments, shear forces and thrusts developed due to the various loading conditions by any classical methods such as moment distribution method, slope deflection method etc. It becomes very tedious for the designer to arrive at design forces for various loading conditions. Hence a study is made to arrive at the coefficients for moments, shear forces and axial thrusts for different loading cases and for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 for three cell box culvert.

This enables the designer to decide the combination of various loading cases to arrive at the maximum design forces at the critical section thus saving considerable design time and effort.

Keywords: design coefficients, three cell, culvert, moment, axial thrust, shear.

I. General

RCC box culverts comprising of top slab, base slab and stem are cast monolithically to carry live load, embankment load, water pressure and lateral earth pressure in a better way. They may be either single cell or multiple cells. The top of the box may be at road level or it may at a depth below the road level if the road is in embankment. The required height and number of boxes depends on hydraulic and other requirements at the site such as road level, nalla bed level, scour depth etc. The barrel of the box culvert should be of sufficient length to accommodate the carriageway and the kerbs.

II. Loads

The loads considered for the analysis of box culverts are Dead load, Live load, Soil pressure on side walls, Surcharge due to live load, and Water pressure from inside.

a) Uniform Distributed Load

The weight of embankment, deck slab and the track load are considered to be uniformly distributed loads on the top slab with the uniform soil reaction on the bottom slab. For live load distribution, the width of dispersion perpendicular to the span is computed first. Width of dispersion parallel to the span is also calculated. Then the maximum magnitude of load is divided by width of dispersion parallel to span and width of dispersion perpendicular to the span to get the load intensity on the top slab.

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b) Weight of Side Walls

The self weight of two side walls acting as concentrated loads are assumed to produce uniform soil reaction on the bottom slab.

c) Water Pressure Inside Culvert

The pressure distribution on side walls is assumed to be triangular with a maximum pressure intensity of p=wh at the base, where w is the density of water and h is the depth of flow.

d) Earth Pressure on Vertical Side Walls

The earth pressure on the vertical side walls of the box culvert is computed according to the Coloumb's theory. The earth pressure intensity on the side walls is given by $p=K_a\gamma H$, where Ka is coefficient of active earth pressure, γ is the density of soil and H is he vertical height of box.

e) Uniform Lateral Load on Side Walls

Uniform lateral pressure on vertical side walls is considered due to the sum of effect of embankment loading and live load surcharge. Also the uniform lateral pressure on vertical side walls is considered due to embankment loading alone.

III. Design Moments, Shears and Thrusts

The box culvert is analysed for moments, shear forces and axial thrusts developed at the critical sections due to the various loading conditions by moment distribution method. The critical sections considered are at the centre of top slab, bottom slab and vertical slab and at the corners of top slab, bottom slab and vertical wall. The moments, shear forces and axial thrusts at the critical sections for different loading cases are computed for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 for three cell box culverts.

IV. Design Coefficients for Moments, Shears and Thrusts

The design coefficients for moments, shear forces and axial thrusts at the critical sections for different loading cases are computed for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 for three cell box culverts.

a) Uniform Distributed Load

Design coefficient for moment = M/wL^2

Design coefficient for shear = V/ wL

Design coefficient for thrust = N /wL

where,

w is the sum of weight of embankment, deck slab and track load.

b) Weight of Side Walls

Design coefficient for moment = M / WL

Design coefficient for shear = V / W

Design coefficient for thrust = N / W

where,

W is the weight of each vertical side wall

c) Water Pressure Inside Culvert

Design coefficient for moment = M / pL^2

Design coefficient for shear = V / pL

Design coefficient for thrust = N / pL

where,

p is the maximum pressure intensity at the base which is given by wh

w is the density of water and h is the depth of flow

d) Earth Pressure on Vertical Side Walls

Design coefficient for moment = M / pL^2

Design coefficient for shear = V / pL

Design coefficient for thrust = N / pL

where,

M, N, V are the moment, axial thrust and shear at the critical section

p is the earth pressure intensity which is equal to $K_a\gamma H$

γ is the density of soil

H is the vertical height of the box

V. Sign Conventions

The following sign conventions are used in the analysis for moment, shear and thrust:

- Positive moment indicates tension on inside face.
- Positive shear indicates that the summation of force at the left of the section acts outwards when viewed from within.
- Positive thrust indicates compression on the section.

VI. Results and Discussions

The results for the box culvert analysed for moments, shears, and thrusts at the critical sections for various loading conditions are presented in tables (table no.s 1 to 5) and graphs (figure no.s 2 to 11). The variation of bending moment, shear forces and thrusts for various ratios of box culvert can be observed from the graphs plotted for various loading cases. This enables to arrive at the design forces resulting from the combination of the various cases yielding maximum moments and forces at the support and midspan sections.

The various loading cases are as given below:

- Case 1: Uniform Distributed Load due to weight of embankment, deck slab and track load
- Case 2 : Weight of side walls
- Case 3 : Water pressure from inside
- Case 4 : Earth pressure on side walls
- Case 5a : Uniform lateral earth pressure due to superimposed dead load and live load
- Case 5b : Uniform lateral earth pressure due to superimposed dead load only

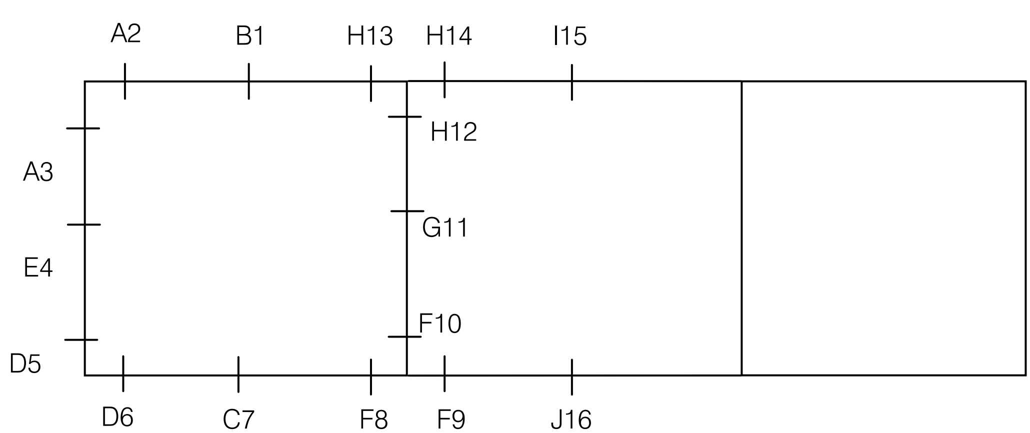

Figure 1 : Critical Sections for three celled box culvert

Table 1 : Coefficients for Moment, Shear and Thrust in three celled box culvert for ratio 1:1

L:H	Section	Coefficients for	Loading Case				
			1	2	3	4	5
1:1	B1	M	+0.063	+0.008	+0.008	-0.008	-0.008
		N	0	-0.077	-0.160	+0.160	+0.494
	A2	M	-0.030	+0.016	+0.023	-0.023	-0.023
		N	0	-0.077	-0.160	+0.160	+0.494
		V	+0.432	-0.017	-0.030	+0.030	+0.030
	A3	M	-0.030	+0.016	+0.023	-0.023	-0.023
		N	+0.432	-0.335	-0.030	+0.030	+0.030
		V	0	-0.017	0.160	-0.160	-0.494
	E4	M	-0.030	-0.023	-0.037	+0.037	+0.098
		N	+0.432	+0.165	-0.030	+0.030	+0.030
	D5	M	-0.030	-0.061	+0.030	-0.030	-0.030
		N	+0.432	+0.665	-0.038	+0.038	+0.038
		V	0	+0.077	-0.340	+0.340	+0.506
	D6	M	-0.030	-0.061	+0.030	-0.030	-0.030
		N	0	+0.077	-0.340	+0.340	+0.506
		V	-0.432	-0.665	+0.038	-0.038	-0.038
	C7	M	+0.063	+0.085	+0.011	+0.011	+0.010
		N	0	+0.077	-0.340	+0.340	+0.506
	F8	M	-0.098	-0.145	-0.009	+0.009	+0.009
		N	0	+0.077	-0.340	+0.340	+0.506
		V	+0.568	+0.835	+0.038	-0.038	-0.038
	F9	M	-0.091	-0.133	-0.004	+0.004	+0.004
		N	0	+0.077	-0.340	+0.340	+0.506
		V	-0.500	0	0	0	0
	F10	M	-0.008	-0.012	-0.005	+0.005	+0.005
		N	+1.068	+0.835	+0.038	-0.038	-0.038
		V	0	-0.013	-0.002	+0.002	+0.002
	G11	M	-0.008	-0.006	-0.005	+0.005	+0.005
		N	+1.068	+0.335	+0.038	-0.038	-0.038
	H12	M	-0.008	+0.001	-0.003	+0.003	+0.003
		N	+1.068	-0.165	+0.030	-0.030	-0.030
		V	0	-0.013	-0.002	+0.002	+0.002
	H13	M	-0.098	-0.003	-0.006	+0.006	+0.006
		N	0	-0.077	-0.160	+0.160	+0.494
		V	-0.568	-0.017	-0.030	+0.030	+0.030
	H14	M	-0.091	-0.004	-0.003	+0.003	+0.004
		N	0	-0.077	-0.160	+0.160	+0.494
		V	0.5	0	0	0	0
	I15	M	+0.034	-0.004	-0.003	+0.003	+0.004
		N	0	-0.004	-0.160	+0.160	+0.494
	J16	M	+0.034	-0.133	-0.004	+0.004	+0.004
		N	0	+0.077	-0.340	+0.340	+0.506

Table 2 : Coefficients for Moment, Shear and Thrust in three celled box culvert for ratio 1.25:1

L:H	Section	Coefficients for	Loading Case				
			1	2	3	4	5
1.25:1	B1	M	+0.061	+0.006	+0.005	-0.005	-0.005
		N	0	-0.106	-0.129	+0.129	+0.395
	A2	M	-0.035	+0.016	+0.014	-0.014	-0.014
		N	0	-0.106	-0.129	+0.129	+0.395
		V	+0.437	-0.019	-0.018	+0.018	+0.018
	A3	M	-0.035	+0.016	+0.014	-0.014	-0.014
		N	+0.437	-0.325	-0.018	+0.018	+0.018
		V	0	-0.019	0.129	-0.129	-0.395
	E4	M	-0.035	-0.026	-0.025	+0.025	+0.064

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		N	+0.437	+0.175	-0.018	+0.018	+0.018
	D5	M	-0.035	-0.068	+0.017	-0.017	-0.017
		N	+0.437	+0.675	-0.023	+0.023	+0.023
		V	0	+0.106	-0.271	+0.271	+0.404
	D6	M	-0.035	-0.068	+0.017	-0.017	-0.017
		N	0	+0.106	-0.271	+0.271	+0.404
		V	-0.437	-0.675	+0.023	-0.023	-0.023
	C7	M	+0.061	+0.083	+0.006	+0.006	+0.006
		N	0	+0.106	-0.271	+0.271	+0.404
	F8	M	-0.098	-0.144	-0.005	+0.005	+0.005
		N	0	+0.106	-0.271	+0.271	+0.404
		V	+0.563	+0.828	+0.023	-0.023	-0.023
	F9	M	-0.090	-0.132	-0.002	+0.002	+0.002
		N	0	+0.106	-0.271	+0.271	+0.404
		V	-0.500	0	0	0	0
	F10	M	-0.008	-0.012	-0.003	+0.003	+0.003
		N	+1.063	+0.828	+0.023	-0.023	-0.023
		V	0	-0.015	-0.001	+0.001	+0.001
	G11	M	-0.008	-0.006	-0.003	+0.003	+0.009
		N	+1.063	+0.328	+0.023	-0.023	-0.023
	H12	M	-0.008	0	-0.002	+0.002	+0.002
		N	+1.063	-0.172	+0.018	-0.018	-0.018
		V	0	-0.015	-0.001	+0.001	+0.001
	H13	M	-0.098	-0.003	-0.004	+0.004	+0.004
		N	0	-0.106	-0.129	+0.129	+0.395
		V	-0.563	-0.019	-0.018	+0.018	+0.018
	H14	M	-0.090	-0.003	-0.002	+0.002	+0.002
		N	0	-0.106	-0.129	+0.129	+0.395
		V	0.5	0	0	0	0
	I15	M	+0.035	-0.003	-0.002	+0.002	+0.002
		N	0	-0.106	-0.129	+0.129	+0.395
	J16	M	+0.035	-0.132	-0.002	+0.002	+0.002
		N	0	+0.106	-0.271	+0.271	+0.404

Table 3 : Coefficients for Moment, Shear and Thrust in three celled box culvert for ratio 1.5:1

L:H	Section	Coefficients for	Loading Case				
			1	2	3	4	5
1.5:1	B1	M	+0.059	+0.006	+0.003	-0.003	-0.003
		N	0	-0.133	-0.108	+0.108	+0.329
	A2	M	-0.038	+0.016	+0.009	-0.009	-0.009
		N	0	-0.133	-0.108	+0.108	+0.329
		V	+0.441	-0.020	-0.012	+0.012	+0.012
	A3	M	-0.038	+0.016	+0.009	-0.009	-0.009
		N	+0.441	-0.318	-0.012	+0.012	+0.012
		V	0	-0.020	0.108	-0.108	-0.329
	E4	M	-0.038	-0.029	-0.018	+0.018	+0.045
		N	+0.441	+0.182	-0.012	+0.012	+0.012
	D5	M	-0.038	-0.073	+0.011	-0.011	-0.011
		N	+0.441	+0.682	-0.015	+0.015	+0.015
		V	0	+0.133	-0.225	+0.225	+0.336
	D6	M	-0.038	-0.073	+0.011	-0.011	-0.011
		N	0	+0.133	-0.225	+0.225	+0.336
		V	-0.441	-0.682	+0.015	-0.015	-0.015
	C7	M	+0.059	+0.082	+0.004	+0.004	+0.004
		N	0	+0.133	-0.225	+0.225	+0.336
	F8	M	-0.097	-0.143	-0.004	+0.004	+0.004
		N	0	+0.133	-0.225	+0.225	+0.336
		V	+0.559	+0.822	+0.015	-0.015	-0.015

	F9	M	-0.089	-0.131	-0.001	+0.001	+0.001
		N	0	+0.133	-0.225	+0.225	+0.336
		V	-0.500	0	0	0	0
	F10	M	-0.008	-0.012	-0.002	+0.002	+0.002
		N	+1.059	+0.822	+0.015	-0.015	-0.015
		V	0	-0.018	-0.001	+0.001	+0.001
	G11	M	-0.008	-0.006	-0.002	+0.002	+0.002
		N	+1.059	+0.322	+0.015	-0.015	-0.015
	H12	M	-0.008	0	-0.002	+0.002	+0.001
		N	+1.059	-0.178	+0.012	-0.012	-0.012
		V	0	-0.018	-0.001	+0.001	+0.001
	H13	M	-0.097	-0.003	-0.003	+0.003	+0.003
		N	0	-0.133	-0.108	+0.108	+0.329
		V	-0.559	-0.020	-0.012	+0.012	+0.012
	H14	M	-0.089	-0.003	-0.001	+0.001	+0.001
		N	0	-0.133	-0.108	+0.108	+0.329
		V	0.5	0	0	0	0
	I15	M	+0.036	-0.003	-0.001	+0.001	+0.001
		N	0	-0.133	-0.108	+0.108	+0.329
	J16	M	+0.036	-0.131	-0.001	+0.001	+0.001
		N	0	+0.133	-0.225	+0.225	+0.336

Table 4 : Coefficients for Moment, Shear and Thrust in three celled box culvert for ratio 1.75:1

L:H	Section	Coefficients for	Loading Case				
			1	2	3	4	5
1.75:1	B1	M	+0.057	+0.006	+0.002	-0.002	-0.002
		N	0	-0.162	-0.093	+0.093	+0.283
	A2	M	-0.042	+0.015	+0.006	-0.006	-0.006
		N	0	-0.162	-0.093	+0.093	+0.283
		V	+0.445	-0.019	-0.008	+0.008	+0.008
	A3	M	-0.042	+0.015	+0.006	-0.006	-0.006
		N	+0.445	-0.313	-0.008	+0.008	+0.008
		V	0	-0.019	0.093	-0.093	-0.283
	E4	M	-0.042	-0.031	-0.014	+0.014	+0.034
		N	+0.445	+0.187	-0.008	+0.008	+0.008
	D5	M	-0.042	-0.078	+0.008	-0.008	-0.008
		N	+0.445	+0.687	-0.010	+0.010	+0.010
		V	0	+0.162	-0.193	+0.193	+0.288
	D6	M	-0.042	-0.078	+0.008	-0.008	-0.008
		N	0	+0.162	-0.193	+0.193	+0.288
		V	-0.445	-0.687	+0.010	-0.010	-0.010
	C7	M	+0.057	+0.080	+0.003	+0.003	+0.003
		N	0	+0.162	-0.193	+0.193	+0.288
	F8	M	-0.097	-0.142	-0.002	+0.002	+0.002
		N	0	+0.162	-0.193	+0.193	+0.288
		V	+0.555	+0.816	+0.010	-0.010	-0.010
	F9	M	-0.088	-0.130	-0.001	+0.001	+0.001
		N	0	+0.162	-0.193	+0.193	+0.288
		V	-0.500	0	0	0	0
	F10	M	-0.009	-0.012	-0.002	+0.002	+0.002
		N	+1.055	+0.816	+0.010	-0.010	-0.010
		V	0	-0.019	-0.001	+0.001	0
	G11	M	-0.009	-0.006	-0.002	+0.002	+0.002
		N	+1.055	+0.316	+0.010	-0.010	-0.010
	H12	M	-0.009	-0.001	-0.001	+0.001	+0.001
		N	+1.055	-0.184	+0.008	-0.008	-0.008
		V	0	-0.019	-0.001	+0.001	+0.001
	H13	M	-0.097	-0.004	-0.002	+0.002	+0.002
		N	0	-0.162	-0.093	+0.093	+0.283

		V	-0.555	-0.019	-0.008	+0.008	+0.008
	H14	M	-0.088	-0.003	-0.001	+0.001	+0.001
		N	0	-0.162	-0.093	+0.093	+0.283
		V	0.5	0	0	0	0
	I15	M	+0.037	-0.003	-0.001	+0.001	+0.001
		N	0	-0.162	-0.093	+0.093	+0.283
	J16	M	+0.037	-0.130	-0.001	+0.001	+0.001
		N	0	+0.162	-0.193	+0.193	+0.288

Table 5 : Coefficients for Moment, Shear and Thrust in three celled box culvert for ratio 2:1

L:H	Section	Coefficients for	Loading Case				
			1	2	3	4	5
2:1	B1	M	+0.056	+0.005	+0.002	-0.002	-0.001
		N	0	-0.191	-0.081	+0.081	+0.247
	A2	M	-0.044	+0.015	+0.004	-0.004	-0.004
		N	0	-0.191	-0.081	+0.081	+0.247
		V	+0.448	-0.019	-0.006	+0.006	+0.006
	A3	M	-0.044	+0.015	+0.004	-0.004	-0.004
		N	+0.448	-0.310	-0.006	+0.006	+0.006
		V	0	-0.019	0.081	-0.081	-0.247
	E4	M	-0.044	-0.033	-0.011	+0.011	+0.026
		N	+0.448	+0.190	-0.006	+0.006	+0.006
	D5	M	-0.044	-0.081	+0.005	-0.005	-0.005
		N	+0.448	+0.690	-0.007	+0.007	+0.007
		V	0	+0.191	-0.168	+0.168	+0.251
	D6	M	-0.044	-0.081	+0.005	-0.005	-0.005
		N	0	+0.191	-0.168	+0.168	+0.251
		V	-0.448	-0.690	+0.007	-0.007	-0.007
	C7	M	+0.056	+0.078	+0.002	+0.002	+0.002
		N	0	+0.191	-0.168	+0.168	+0.251
	F8	M	-0.096	-0.141	-0.002	+0.002	+0.002
		N	0	+0.191	-0.168	+0.168	+0.251
		V	+0.552	+0.809	+0.007	-0.007	-0.007
	F9	M	-0.088	-0.129	-0.001	+0.001	+0.001
		N	0	+0.191	-0.168	+0.168	+0.251
		V	-0.500	0	0	0	0
	F10	M	-0.009	-0.012	-0.001	+0.001	+0.001
		N	+1.052	+0.809	+0.007	-0.007	-0.007
		V	0	-0.021	-0.001	+0.001	+0.001
	G11	M	-0.009	-0.007	-0.001	+0.001	+0.001
		N	+1.052	+0.309	+0.007	-0.007	-0.007
	H12	M	-0.009	-0.001	-0.001	+0.001	+0.001
		N	+1.052	-0.191	+0.006	-0.006	-0.006
		V	0	-0.021	-0.001	+0.001	+0.001
	H13	M	-0.096	-0.004	-0.001	+0.001	+0.001
		N	0	-0.191	-0.081	+0.081	+0.247
		V	-0.552	-0.019	-0.006	+0.006	+0.006
	H14	M	-0.088	-0.002	-0.001	+0.001	+0.001
		N	0	-0.191	-0.081	+0.081	+0.247
		V	0.5	0	0	0	0
	I15	M	+0.037	-0.002	-0.001	+0.001	+0.001
		N	0	-0.191	-0.081	+0.081	+0.247
	J16	M	+0.037	-0.129	-0.001	+0.001	+0.001
		N	0	+0.191	-0.168	+0.168	+0.251

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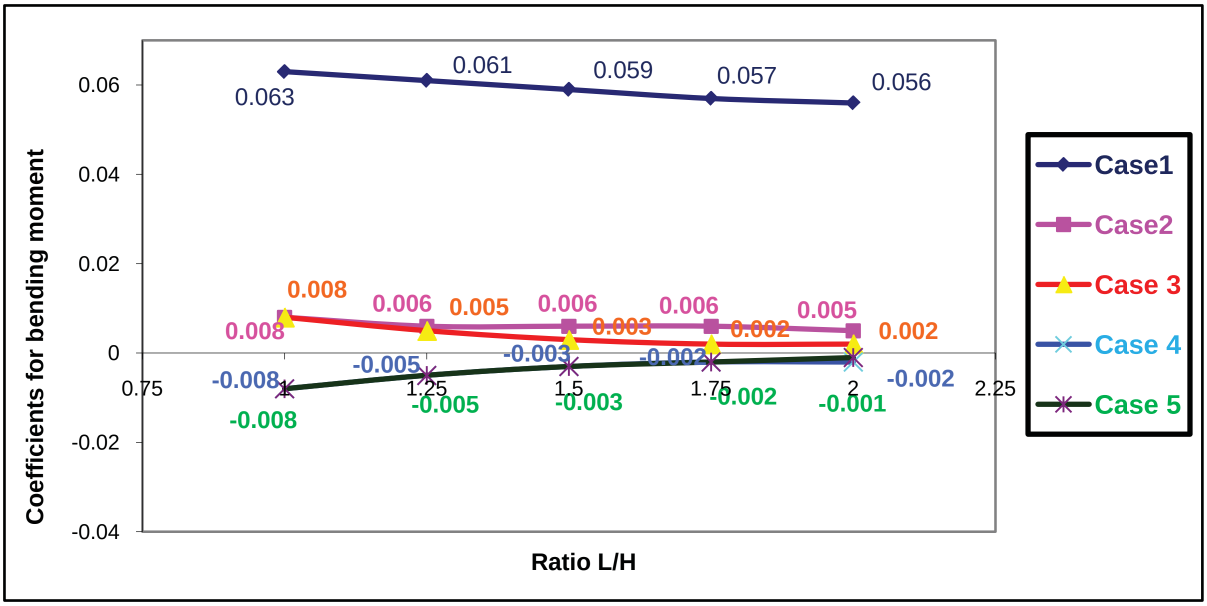

Figure 2 : Coefficients for BM at section B1 in three cell box culvert

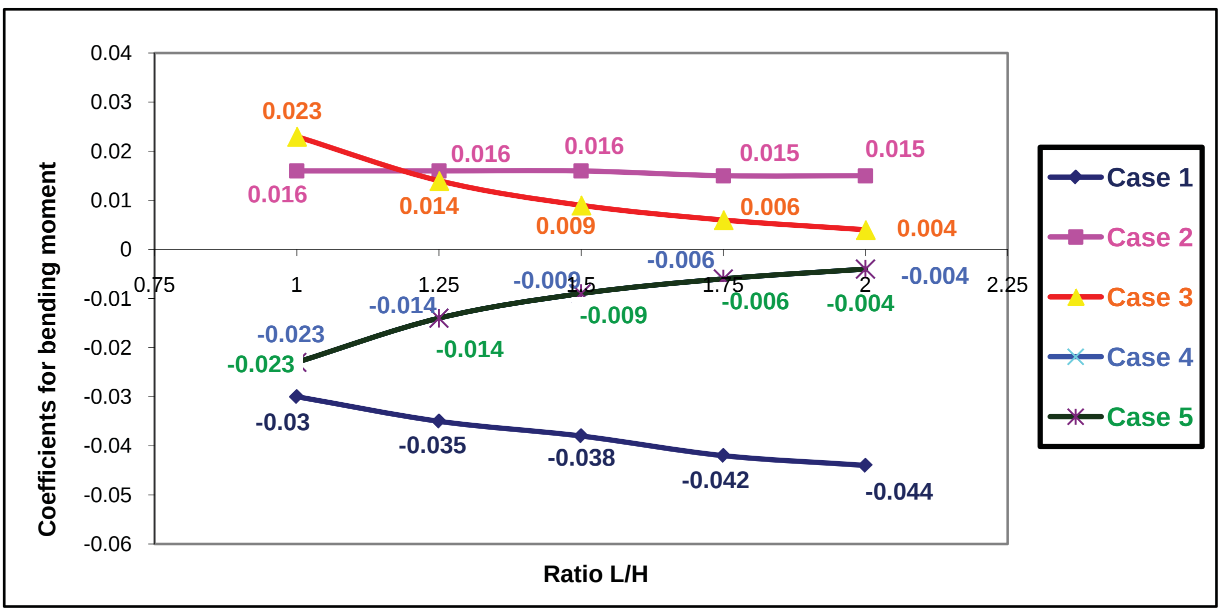

Figure 3 : Coefficients for BM at section A2 & A3 in three cell box culvert

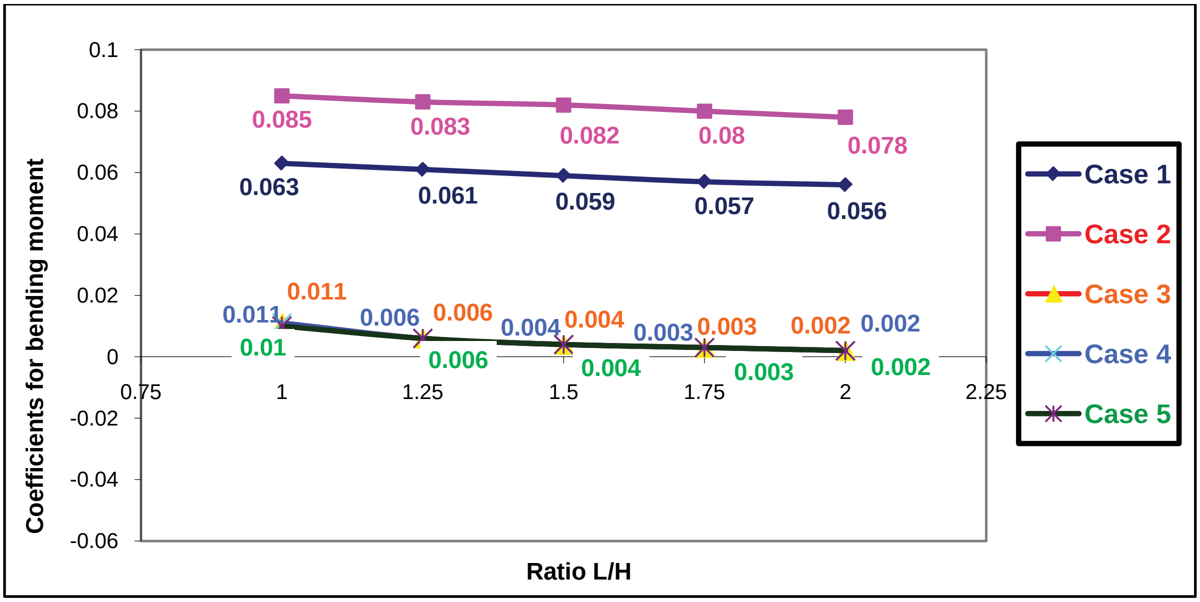

Figure 4 : Coefficients for BM at section C7 in three cell box culvert

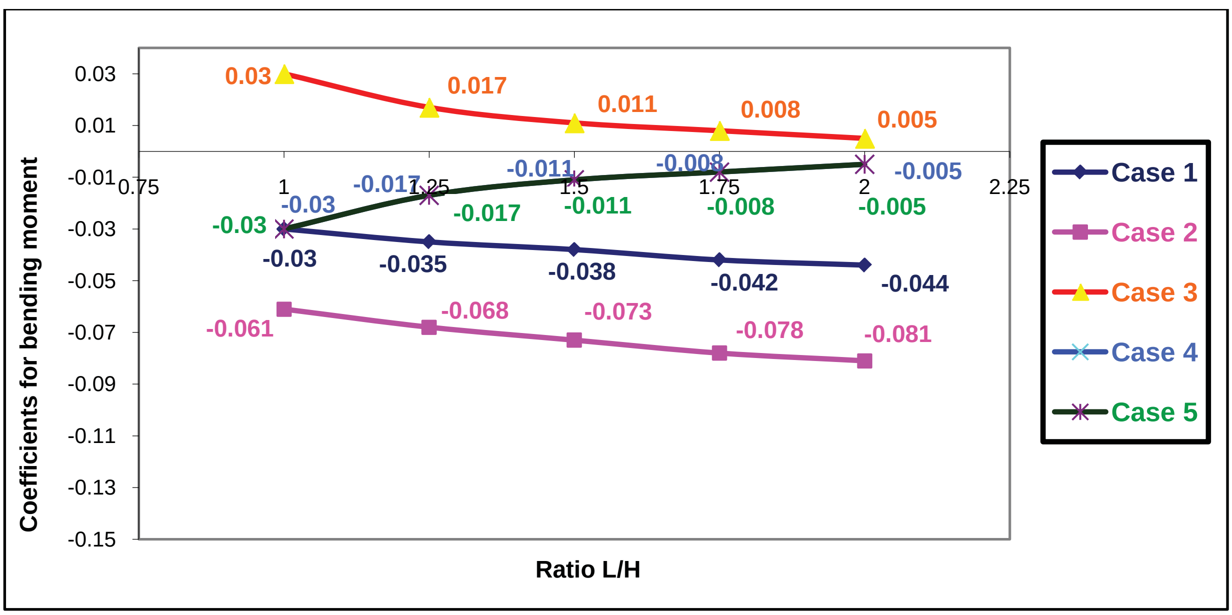

Figure 5 : Coefficients for BM at section D5&D6 in three cell box culvert

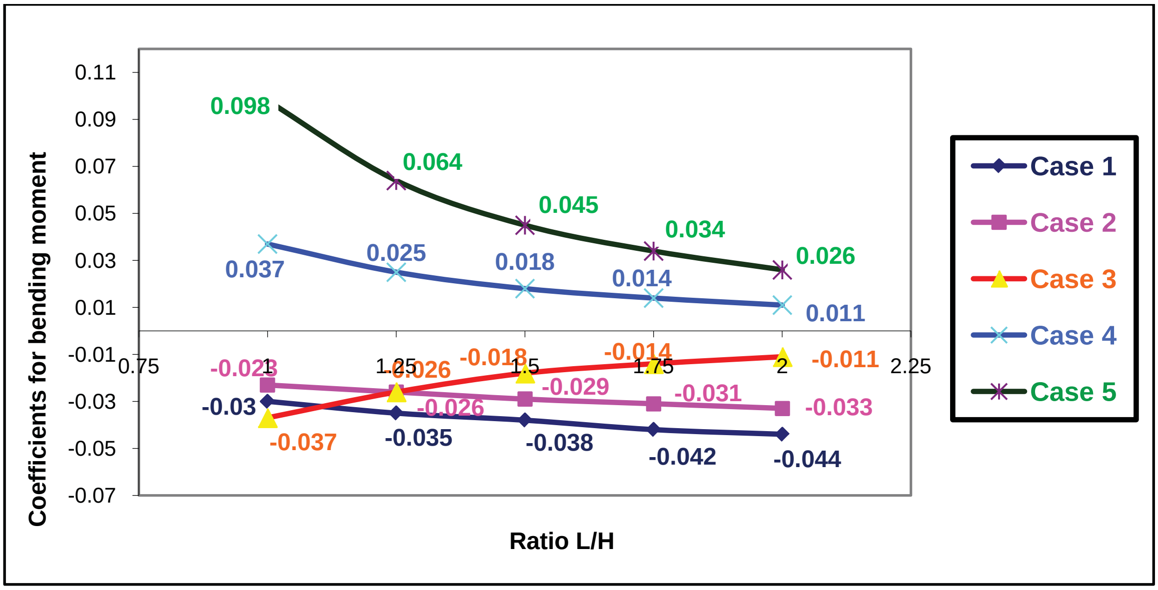

Figure 6 : Coefficients for BM at section E4 in three cell box culvert

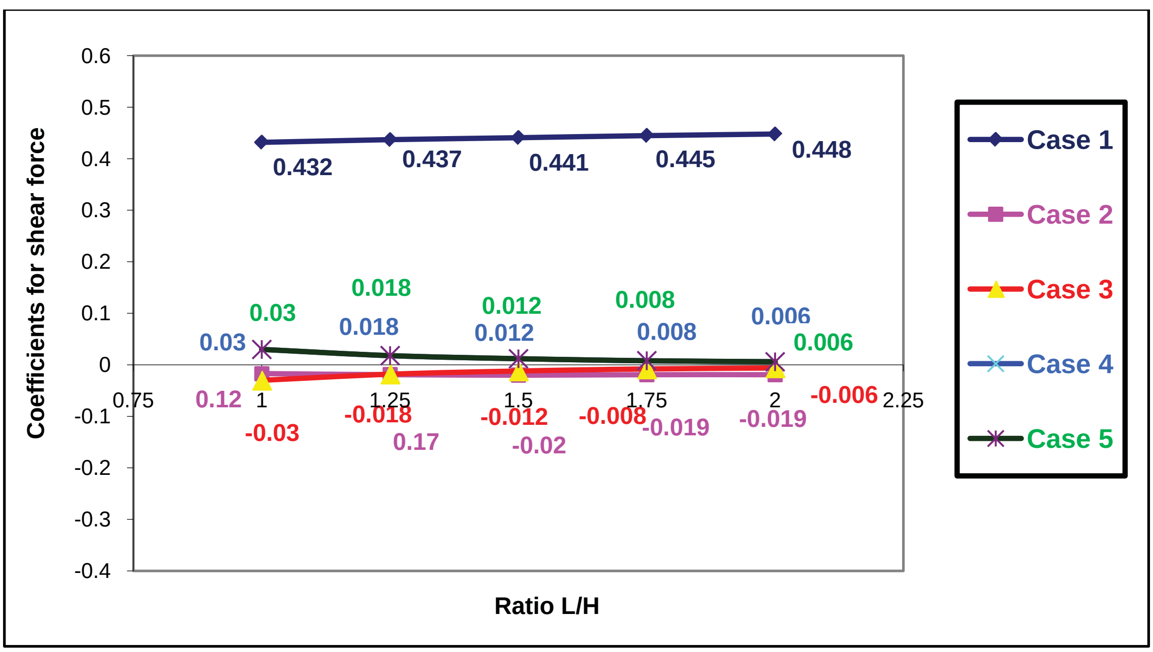

Figure 7 : Coefficients for SF at section A2 in three cell box culvert

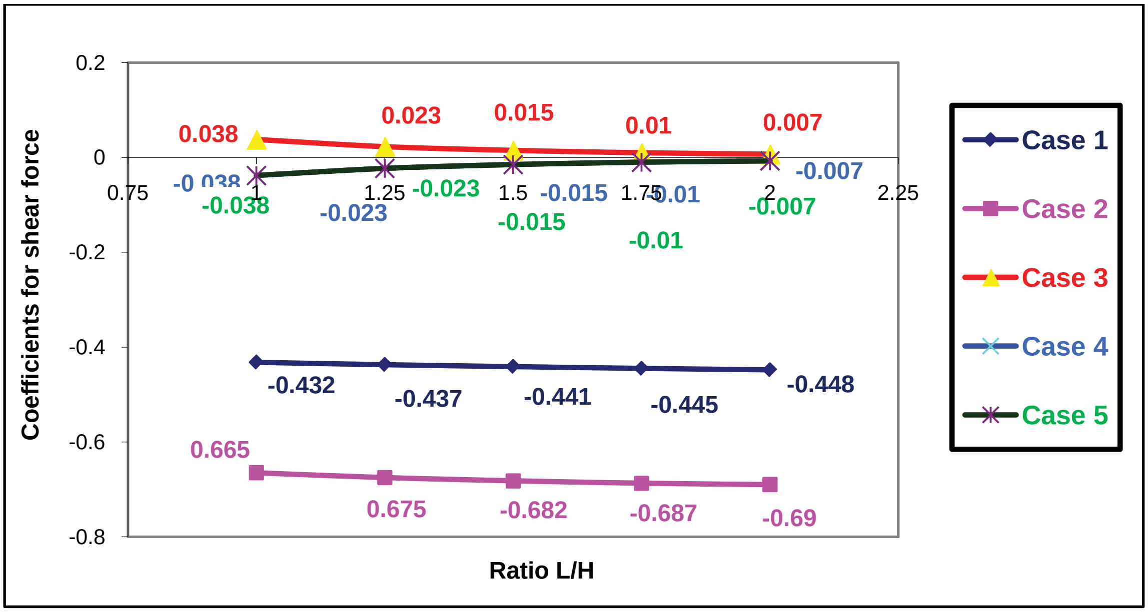

Figure 8 : Coefficients for SF at section D6 in three cell box culvert

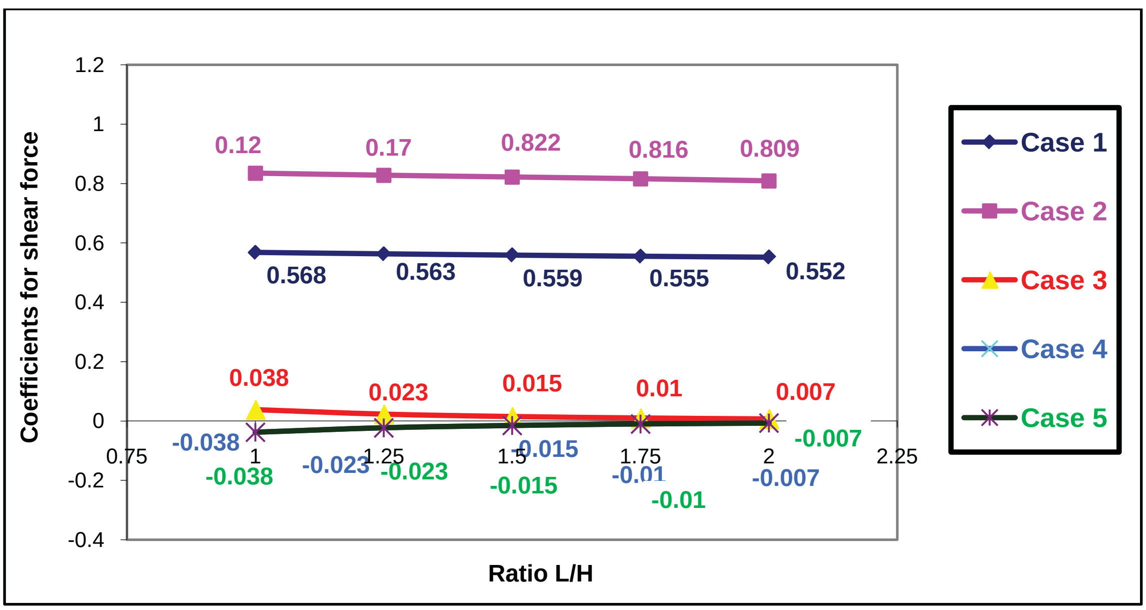

Figure 9 : Coefficients for SF at section F8 in three cell box culvert

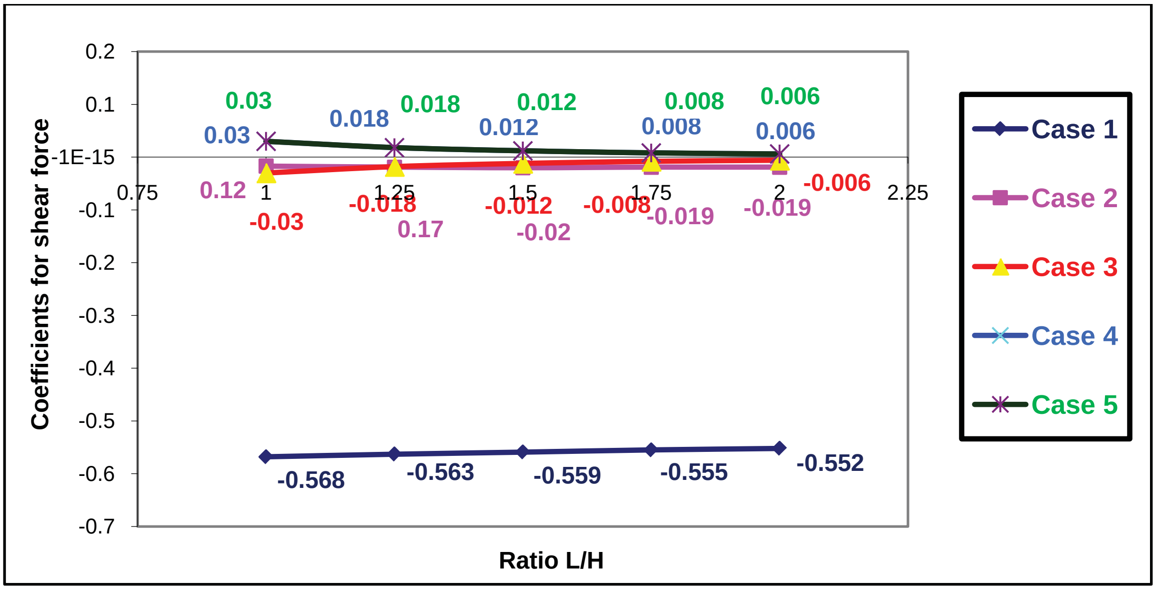

Figure 10 : Coefficients for SF at section H13 in three cell box culvert

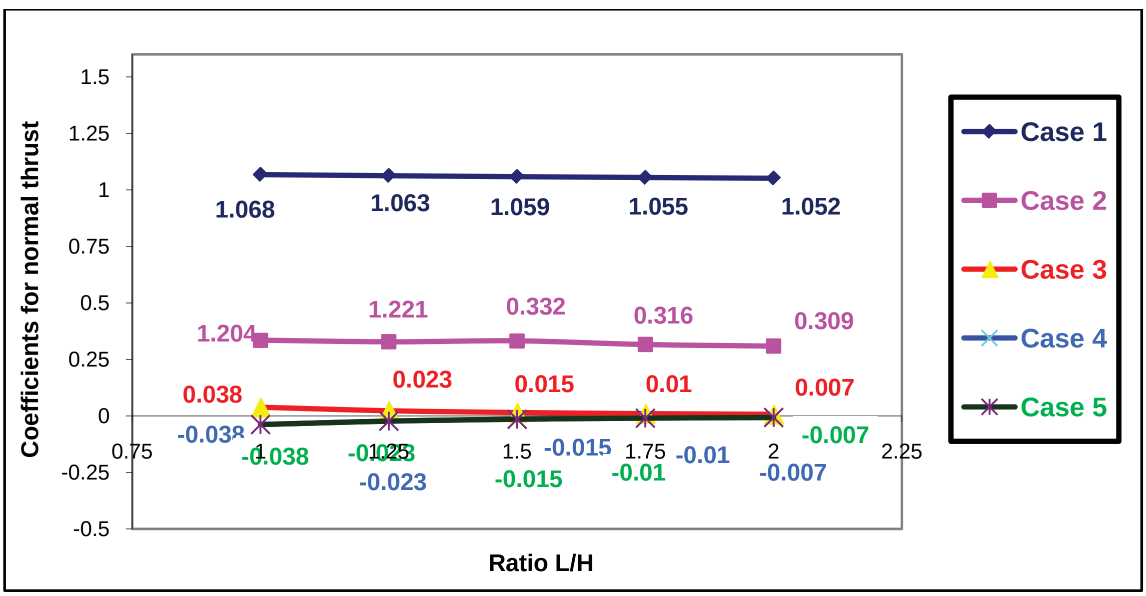

Figure 11 : Coefficients for Normal thrust at section G11 in three cell box culvert

VII. Discussions on Three Cell Box Culvert

The maximum positive moment develop at the centre of top slab when the culvert is running full and uniform lateral pressure due to superimposed dead load only as shown in figure 2. As the span increases, there is significant contribution to positive bending moment due to dead load and live load only as the contribution due to earth pressure becomes less significant.

It is seen from figure 3 that the maximum negative moment develop at the corner of top slab when the culvert is empty and the top slab carries the dead load and live load. The weight of side walls decreases the net negative moment as the moment due to side walls is positive. As the span increases, there is significant contribution to negative bending moment due to dead load and live load only as the contribution due to earth pressure becomes less significant.

The maximum positive moment develop at the centre of bottom slab when the culvert is running full and uniform lateral pressure due to superimposed dead load and live load (referring fig.4). As the span increases, there is significant contribution to positive bending moment due to dead load and live load only as the contribution due to earth pressure becomes less significant. The weight of side walls also has the significant effect on net positive bending moment.

The maximum negative moment develop at the corner of bottom slab when the culvert is empty and the top slab carries the dead load and live load as shown in figure 5. There is significant contribution to maximum negative moment due to weight of side walls. As the span increases, there is contribution to negative bending moment due to dead load and live load only as the contribution due to earth pressure becomes less significant.

From figure 6 , it can be seen that the maximum negative moment develop at the centre of vertical wall when the culvert is running full and when uniform lateral pressure due to superimposed dead load acts only. As the span increases, there is significant contribution to negative bending moment due to dead load and live load only as the contribution due to water pressure becomes less significant.

The maximum positive shear force occurs at section A2 in the top slab and at section F8 in the bottom slab due to the superimposed dead load and live load case only as seen from figures 7 and 9. As seen in figures 8 and 10, the maximum negative shear occurs at section D6 in the bottom slab and at section H13 in the top slab. There is significant contribution to shear force values due to weight of side walls at section D6 and F8. The maximum positive normal thrust occurs at mid height of vertical wall due to superimposed dead and live load and due to weight of side walls as seen in figures 11.

VIII. Conclusions

The present study makes an effort to evaluate the design coefficients for bending moment, shear force and normal thrust for three celled box culvert subject to various loading cases. An attempt is made to provide the information of the effects for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 three celled box culverts. The results of the study lead to the following conclusions:

a) The design coefficients developed for bending moment, shear and normal thrust at critical sections for various loading cases enables the designer to arrive at design forces thus reducing design time and effort.

b) The critical sections considered are the centre of span of top and bottom slabs and the support sections and at the centre of the vertical walls since the maximum design forces develop at these sections due to various combinations of loading patterns.

c) The study shows that the maximum design forces develop for the following loading conditions:

   i. When the top slab supports the dead load and live load and the culvert is empty.
   ii. When the top slab supports the dead load and live loads and the culvert is running full.
   iii. When the sides of the culvert do not carry the live load and the culvert is running full.

d) The study shows that the maximum positive moment develop at the centre of top and bottom slab for the condition that the sides of the culvert not carrying the live load and the culvert is running full of water.

e) The maximum negative moments develop at the support sections of the bottom slab for the condition that the culvert is empty and the top slab carries the dead load and live load.

f) The maximum negative moment develop at the centre of vertical wall when the culvert is running full and when uniform lateral pressure due to superimposed dead load acts only.

g) The maximum shear forces develop at the corners of top and bottom slab when the culvert is running full and the top slab carries the dead and live load,

h) The study shows that there is significant contribution to positive normal thrust at centre of vertical wall (section E4) due to superimposed dead load & live load and weight of side walls.

i) The study shows that the multi celled box culverts are more economical for larger spans compared to single cell box culvert as the maximum bending moment and shear force values decreases considerably, thus requiring thinner sections.

IX. Acknowledgements

The authors thank the Principal and Management of S.G.Balekundri Institute of Technology, Belgaum and KLS Gogte Institute of Technology, Belgaum for the continued support and cooperation in carrying out this research study.

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Enhanced Ergonomics Training; A Requisite to Safe Body Postures in Manual Lifting Tasks

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Abstract - This study evaluated working postures adopted by construction workers in Southwestern Nigeria. The objective was to compare risk factors among the group of workers. About 844 working postures were analyzed using Ovako Working Postures Analyzing System (OWAS). Semi-structured interviews were also conducted on different body regions regarding work related pains for 250 healthy Bricklayers (BL) and Bricklayers' Assistants (BA). More than forty nine percent (49%) of the postures observed were classified as Action Family 3 (AF3) (distinctly harmful) and AF4 (Action Family 4) (extremely harmful). The percentage of harmful postures for BL was higher with fifty one (51%) of the total recorded postures. Less than 10% of the total workers reported to have adopted ergonomics training and found it secured. Meanwhile more than sixty percent (60%) of them complained of pains in their various body regions. The study revealed that majority of the workers had no exposure to ergonomics training hence adopted harmful postures at work. BL are at a higher risk. Advancement in practical ergonomics trainings on safe postures in manual lifting tasks is a necessity.

Keywords : workers; construction; manual; tasks; lifting; pain; safe; posture; ergonomics; training.

GJRE-E Classification : FOR Code: 120399, 290899

ENHANCEDERGONOMICSTRAININGAREQUISITETOSAFEBODYPOSTURESINMANUALLIFTINGTASKS

Enhanced Ergonomics Training; A Requisite to Safe Body Postures in Manual Lifting Tasks

Oluwole Adeyemi [α], Samuel Adejuyigbe [σ], Olusegun Akanbi [ω], Salami Ismaila [ρ] & Adebayo Adekoya [¥]

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I. Introduction

Awkward posture is a considerable deviation from the neutral position of one or combination of joints (Pinzke and Kopp, 2001). According to Westgaard and Aaras (1984), these postures typically include reaching behind, twisting, working ahead, wrist bending, kneeling, stooping, forward and backward bending, and squatting. It was further stated that such postures are related to injuries that are incurred during tasks that are static in nature, long lasting and that demand exertion of force.

It is documented that there is a relationship between awkward postures and pain (Grandjean and Hunting, 1977). Awkward postures combined with heavy physical workload result in a high frequency of Work related Musculoskeletal disorders (WMSDs) (Pinke and Kopp, 2001). Body postures determine which joints and muscles are used in an activity and the amount of force or stresses generated (Putz-Anderson, 1998). According to Kerst (2003), extreme postures, combined with force and frequency, will cause damage more quickly than when the postures are more natural or neutral.

The increase in concerns for ergonomics issues in the workplace is well founded; as it is related to work, working position; the suitability of instruments to the physical and physiological characteristics of the workers, psychological factors and environmental conditions which may affect workplaces and affect the health of the workers (Bazroy, et.al., 2003; Ajimotokan, 2008).

The amount of fatigue experienced depends largely on the posture of the performer. Many of the conditions of musculoskeletal disorders could be prevented if the amount of awkward, heavy, repetitive activities required by the job is reduced (OSHA's 1999).

OWAS has been shown to be easy to use in analyzing a wide range of different postures and a suitable tool in analyzing construction jobs. The basic OWAS records the postures of the back, arms and legs (Mattila, et.al., 1993: Karhu et.al., 1981). Kivi and Mattila (1991) and Mattila et al. (1993) analyzed the working postures of construction workers using OWAS method. Their studies indicated that OWAS was a suitable, reliable and practical method for analyzing construction jobs. Lee and Han (2013) used OWAS to analyze the working postures of construction workers on building the foundations of a log cabin. The study discovered workers exhibited poor working posture. Thomas et al., 2007, measured the prevalence of low back pain among 94 residential carpenters using OWAS to measure elements of postures. Slight risk for injury was found in 10 jobs-tasks while distinct risk was found in 7 of the 10 jobs-tasks. The weight carried by workers in brick making factories and positions taken in their daily task were measured using OWAS method and it was concluded that the method is imperative for ergonomics recommendations for minimization or eradication of suffering injury and worker's postural constraints (Pandey and Vats, 2012). Mattila et al., (1993) applied OWAS method to identify the most problematic postures among 18 construction workers in hammering task performed at building construction site to reduce postural load of dynamic hammering tasks. It was concluded that the method proved to be very useful.

The manner in which construction activities are executed adversely affects the health of construction

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workers. Hence, the necessity for more trainings on construction ergonomics which should include health and safety education and general training of workers (Smallwood, 2006). Proper work techniques should include training on the correct lifting procedures. Whereas work methods should be designed to reduce static, extreme and awkward postures among others (WSI, 2003).

Several studies have quantified the benefits that accrue from health and safety training (Jannadi and Al-Sudairi, 1995; Lingard & Rowlinson, 2005) and also confirmed positive correlation between health and safety training and health and safety performance (Rowlinson, 2004; Smallwood, 2006). The trade specific research conducted among bricklayers, plasterers, painters, and their respective assistants suggested a range of interventions that could contribute to an improvement in construction ergonomics one of which included ergonomics training of workers (Samuels et al., 2006). According to Bellis (2007), the goal of ergonomics training in the workplace is to prevent injuries and illnesses by reducing or eliminating worker's exposure to occupational hazards.

The aim of this study is to evaluate workers' postural behaviours at manual material lifting tasks among construction workers.

The objectives of the study are;

a) to compare the contributions of body movement at work to WMSDs
b) to ascertain the level of ergonomics training, its acceptability among the group of workers and its impacts on work methods.

II. Material and Methods

Work place analyses were accomplished by observing the tasks and watching the workers as they were carrying out the manual lifting tasks. An instantaneous observation of the postures and video recording were made which was later played indoor and observed by two ergonomics experts drawn from academics. The OWAS data was analyzed with WinOWAS software, a computerized system for the analysis of work postures. Four-digit code representing the back (four choices), three arm postures, and seven leg postures were used. The use of the weight of loads handled was classified by a three-class scale (as shown in table 1). Postures were recorded for each of the work phase during the working periods and within 30 seconds.

A total of eight hundred and forty-four (844) working postures were recorded and analyzed (four hundred and twenty two (422) for each category of workers). For OWAS method and as adopted in this study, AF2 (Action family 2) are grouped postures that required actions in the nearest future), AF3 are grouped postures that required remedial actions very soon), and AF4 are grouped postures that required immediate remedial actions).

Table 1 : OWAS posture code definitions

Back	Arms	Legs	Load/Use of Force
1 = straight 2 = bent forward or backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	1= both arms below shoulder level 2= one arm at or above shoulder level 3 = both arms at or above shoulder level.	1 = Sitting 2 = Standing on two legs 3 = Standing on One leg 4 = Standing on two bent knees 5= Standing on one bent Knee 6=Kneeling 7=Walking	1= weight or force needed is 10kg or less 2= weight or force needed exceeds 10kg but is less than 20kg 3 = weight or force needed exceeds 20kg.

Questionnaires were conducted through interviews for 250 healthy male workers to identify the musculoskeletal symptoms among the workers. Level of ergonomics information readily made available, its approval among the group of workers and its impacts on their daily lifting tasks methods were also verified.

III. Result and Discussion

Table 1 shows the OWAS code of AF3 and AF4 postures recorded for each category of jobs studied.

A total number of 417 harmful postures representing about forty-nine percent (49.4%) which included 161 and 126 postures for Bricklayers and Bricklayers' Assistants respectively in the group of AF3 and 130 postures (15.4%) involving 52 and 78 postures in the categories of BL and BA respectively for AF4 family were reported (Figure 1).

Close to thirty percent (30%) of BA and about thirty-eight percent (38%) of BL recorded postures fall into the family of AF3. In the family of AF4, about nineteen percent (18.5%) of postures in BA group was reported while approximately twelve percent (12%) of BL postures fall into this category (Fig.2).

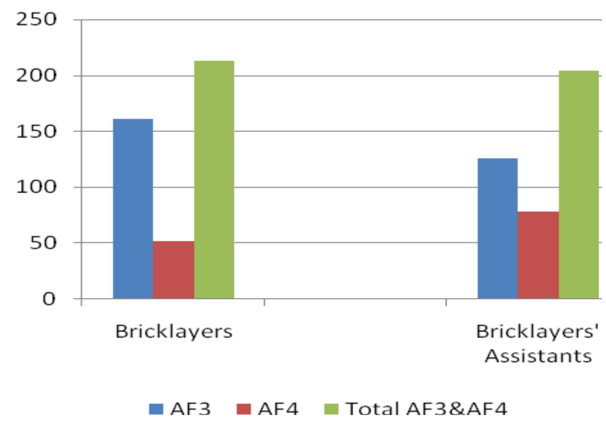

Figure 1 : The AF3 and AF4 postures that required Immediate remedial actions for the two categories of workers

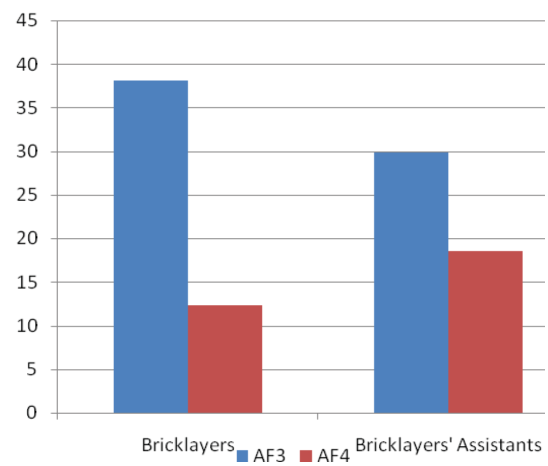

Figure 2 : Percentages of AF3 and AF4 postures that required immediate remedial actions for the two categories of workers

Table 2 : OWAS code of AF3 and AF4 postures for each studied jobs

AF3 POSTURES				AF4 POSTURES			
BRICKLAYERS		BRICKLAYER ASSISTANTS		BRICKLAYERS		BRICKLAYER ASSISTANTS	
CODE	FREQ.	CODE	FREQ.	CODE	FREQ.	CODE	FREQ.
2142	52	2153	63	4141	18	2343	78
3143	32	2143	32	4142	13		
2141	33	1343	31	4143	12		
2142	28			3242	9		
3142	10						
2113	3						
2133	3						
TOTAL	161		126		52		78

Comparing the two jobs (Figure 3), an average of fifty-one percent (51%) postures of workers in BL category and forty-eight percent (48%) postures of the workers in BA group required either soon or immediate remedial actions and ergonomics redesign to reduce the effect of harmful postures.

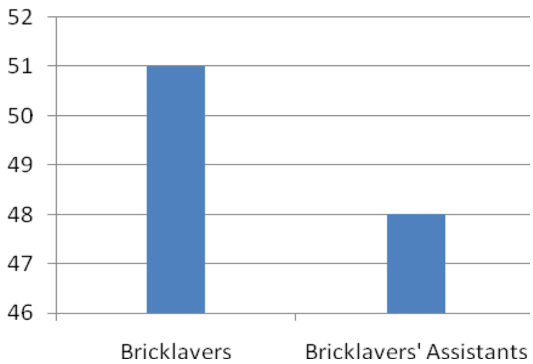

Figure 3 : Percentages of harmful postures that required ergonomics redesign for the two categories of workers

Bricklaying has been shown to cause severe muscle fatigue. Load on the lumbar spine has also been shown to be very high (Jorgensen et al., 1991). Therefore a high prevalence of work related pains among the workers as observed through the interview as summarized in Figure 4 is not surprising. Posture 3143 (3 = back twisted or bent sideways, 1= both arms below should level, 4 = Standing on two bent knees, 3 = weight of load exceeds 20kg) and 2142 (2 = back bent forward or backward, 1= both arms below should level, 4 = Standing on two bent knees, 2= weight of load exceeds 10kg but less than 20kg) are mostly adopted when the workers were lifting up blocks and lowering same which were classified as harmful. The most strenuous postures as observed are 4142 (4 = bent and twisted or bent forward and sideways 1= both arms below should level 4 = Standing on two bent knees 2= weight or force needed exceeds 10kg but is less than 20kg) and 4141 (4 = bent and twisted or bent forward and sideways 1= both arms below should level 4 = Standing on two bent knees 1= weight or force needed is 10kg or less) which were observed when the workers were lifting up blocks and mortars from their sides (unnatural posture).

The awkward postures adopted by the workers' may have contributed to the various reported body pains as observed by more than sixty percent (60%) of the workers responses on the two categories of jobs in the last month and 7days of the study time (Figure 4). One way to reduce the effect created by AF3 and AF4 codes is to minimize the angle of asymmetric; by lifting the load directly from the front thereby maintaining natural postures.

a) *Workers' Responses to Ergonomics Trainings and Impacts on their Manual Lifting Tasks*

Two hundred and thirty three (representing 93.2%) of the total workers that participated in the study completed the questionnaire all of which have spent not less than 2 years on manual material lifting job in construction industry.

About 146 workers (63%) had no regular ergonomics training while 87 of the workers (37%) reported receiving regular training/information from their supervisors. Of the eighty seven workers who regularly receive ergonomics training, twenty one of them, representing 8.4%, have adopted ergonomics postures at work and hence perceived the lifting tasks safer than before the training (Figure 5). Forty of the workers despite receiving ergonomics training had not put it into practice but rather see the recommended postures very demanding. This category of workers perceived repositioning of body to lift at zero degree asymmetric neutral posture) each time of lift, as time wasting most especially to those who are involved in

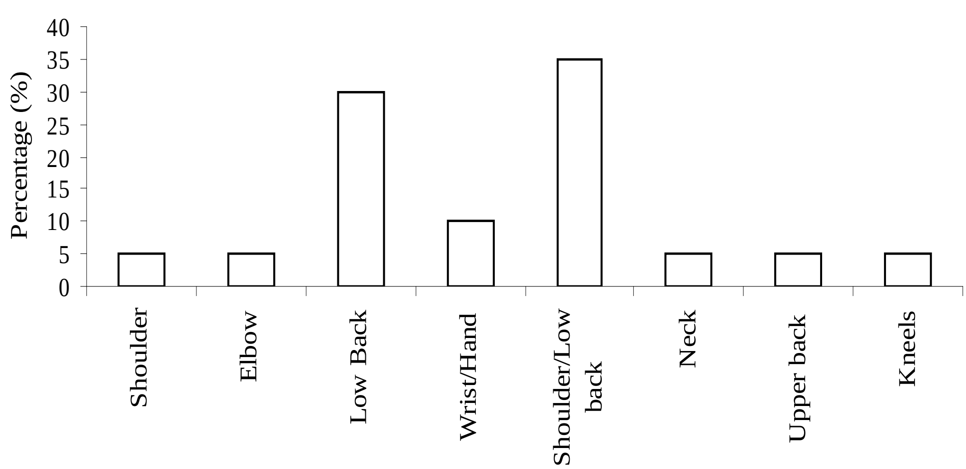

Figure 4 : Percentages of respondents who complained of pains in the last month and last 7 days

repeated and time bound lifting tasks (the like of concrete jobs). Twenty six of the workers however requested for further training to enable them adjust.

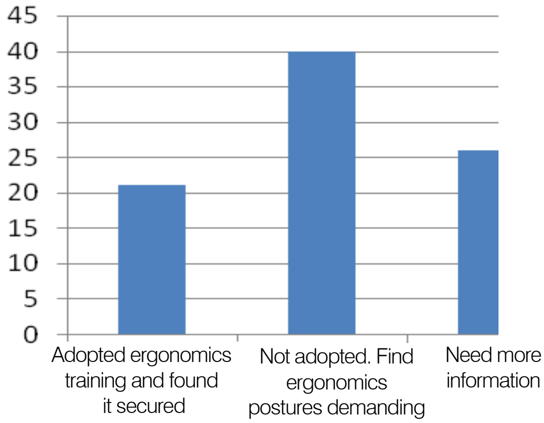

Figure 5 : Workers' responses to ergonomics trainings and impacts

IV. Conclusion

Twisting and bending of body parts are so frequent in the manual lifting jobs. Prolonged bending of back while lifting block/mortar from the sides was identified as most strenuous postures in the course of performing the tasks.

Meanwhile, health hazards are hardly considered by the group of workers. Majority of them had no regular ergonomics training as regarding safe postures. Not many of the trained ones put it into practice while many are still ignorant of the benefits for such change in work methods/habits. The few workers who adopted the training found it secured.

However, the level of ergonomics information made available to the group of workers needs some improvement. Physical demonstration/training on how and the best way to maintain natural postures at manual lifting related task are very necessary most especially in construction trades. Workers also need to be sensitized on the short and long time health implications of working in harmful postures.

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Construction Cost Modeling CCM an Ideal Tool for Value Engineering

By Sunil V Desale & Dr. S V Deodhar
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Abstract - Value Engineering is a systematic method to improve the value by examining different functions."Value "as defined is the ratio of function to cost. Value can therefore be increased by either improving the functions or reducing the cost by saving. The difference between the function-cost and function-worth indicates the measure of the potential for cost saving through Value Engineering. Construction Cost Modeling (CCM) is a useful tool where the cost are disproportionately high when considering there function, use, necessity. Construction Cost Modeling is an advance sophisticated technique for Value Engineering in construction management, where it can lead to very substantial of large and complex construction whose cost are disproportionately high when considering there function ,use or necessity, are highest as ideal subjects for cost reduction efforts.

Keywords : value engineering, construction cost modeling (ccm).

GJRE-E Classification : FOR Code: 290804

CONSTRUCTIONCOSTMODELINGCCMANIDEALTOOLFORVALUEENGINEERING

Strictly as per the compliance and regulations of :

Construction Cost Modeling CCM an Ideal Tool for Value Engineering

Sunil V Desale [α] & Dr. S V Deodhar [σ]

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Keywords: value engineering, construction cost modeling (ccm).

I. Introduction

Value Engineering (VE) is a systematic method to improve the "value" of goods or products and services by using an examination of function. Value, is the ratio of function to cost. Value can therefore be increased by either improving the function or saving the cost. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements. Value engineering is sometimes taught within the project management or construction management as a technique in which the value outputs is optimized by crafting a mix of performance (function) and costs. In most cases this practice identifies and removes unnecessary expenditures, thereby increasing the value for their customers.

Value Engineering follows a structured thought process that is based exclusively on "function", i.e. what something "does" not what it is. This is the basis of what value engineering refers to as "function analysis".

Value Engineering uses rational logic (a unique "how" - "why" questioning technique) and the analysis of function to identify relationships that increase value. It is considered a quantitative method similar to the scientific method, which focuses on hypothesis-conclusion approaches to test relationships, and operations research, which uses model building to identify predictive relationships.

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II. Construction Cost Modeling (CCM)

Value engineering is often done by systematically following a multi-stage job plan. Larry Miles' original system was a six-step procedure which he called the "value analysis job plan." Others have varied the job plan to fit their constraints depending upon the application; they may be four, five, six, or more stages. One modern version has eight steps.

As mention earlier, quite a few refinements, sophistications and advance technique has been added to value engineering. One of them Construction is Cost Modeling CCM; it has the diagrammatic representation of the structure and distribution of cost associated with any project, product or system. In value engineering, it is used to provide an over view of the cost the various element in relation to the other, so that those whose cost are disproportionately high when considering their function, use or necessity .A construction cost module is developed, by breaking down the main project first system under study to its major sub –system, which is further exploded or broken into more details at lower levels in the form of a typical organization chart. The budgeted or estimated cost is then assigned to each element. An overall look at the cost is then assigned to each element in relation to others in the cost structure will highlight those whose costs appear to be too high, when considering their functions and importance. The worth or the lowest cost of providing the essential functions is then assessed by the Team and entered against each element. The difference between the function-cost and function-worth indicates the value gap or value index, which is the measure of the potential for cost saving through Value Engineering. By following the further phases of the VE Job Plan, a large number of ideas for providing the function in other ways are generated through brainstorming, which are then short-listed; investigated and final recommendations are developed. Construction cost modeling is an ideal tool for value engineering in construction management where it can lead to very substantial saving in the execution of large and complex construction projects.

In CCM technique following four basic steps are utilized.

a) Information Gathering

This asks what the requirements are for the object. Function analysis, an important technique in value engineering, is usually done in this initial stage. It tries to determine what functions or performance characteristics are important. It asks questions like;

What does the object do?

What must it do?

What should it do?

What could it do?

What must it not do?

b) Alternative Generations (Creation)

In this stage value engineers ask;

What are the various alternative ways of meeting requirements?

What else will perform the desired function?

c) Evaluation

In this stage all the alternatives are assessed by evaluating.

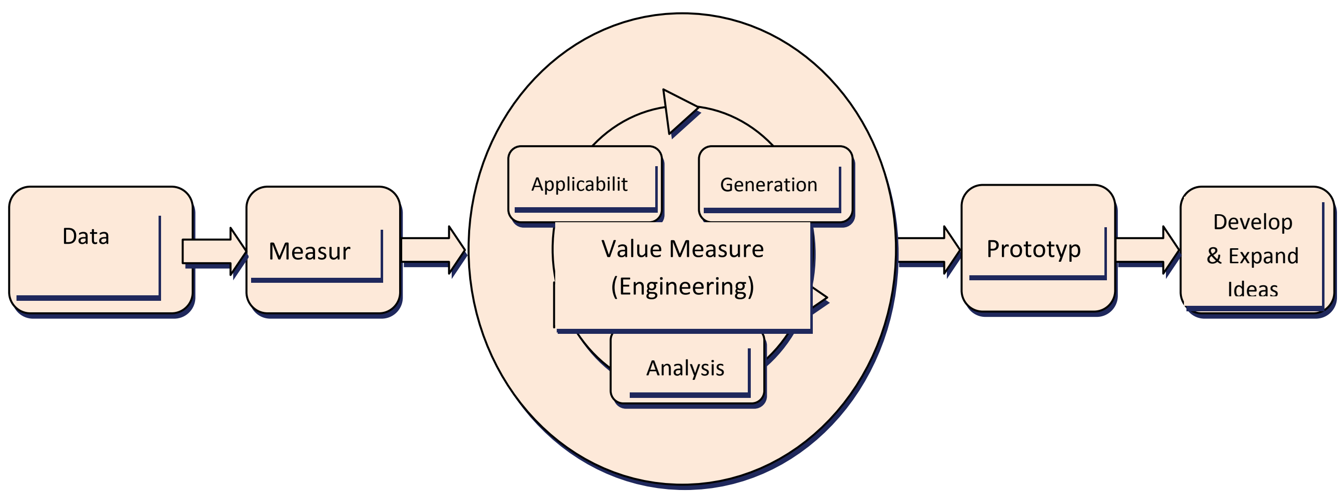
How well they meet the required functions?

How great will the cost savings be?

III. Recommendation

In this final stage, the best alternative will be chosen and recommendation to the client for final decision as ideal for cost reduction effort. Develop thing with collaboration of customer.

Figure 1 : Step in CCM for Value Engineering



IV. Case Study: Setting up of a New Factory

This case study is of a factory located at a distance of 5.5 km from khada village and 1.5 km from Sutrepada village .The access road is khada to Sutrepada a village road of Dhulia Tehsil of district Dhule in Maharashtra State. The factory construction is in survey no. 85 and 88 and the construction of a new loom shade on a land having survey number 105 from the side of lack i.e. Percolation Tank. Figure 2 shows the Layout plan for a recently sited New Factory at Sutrepada at above location. Once the approval was given by the chairman and management of factory, a team of senior executives was assembled under the charge of a General Manager and given the mandate that the project must be completed in time and without asking for additional funds. Unfortunately, there was a steep hike in the price of steel and cement within three months and the new General Manager was hard pressed to find adequate funds for completing the essential part of the project, by effecting economies elsewhere. Therefore to overcome with this problem CCM technique for value engineering is used. The problem was identify first in the project report and then finding out the maximum scope for cost reduction for achieving savings without loosing out on the basic requirements.

V. Methodology

Value Engineering was chosen for achieving cost savings and Cost Modelling for identifying the items where savings potential can be maximum. To start, a Construction Cost Model (as shown in Fig.3) was prepared in which all major items of expenditure were shown, under four board headings on one sheet of paper, in order to provide an overview of the costs in relation to one another and to highlight those which were disproportionately high considering their purpose and necessity.

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After diagrammatic representation of all the expenditures occurred under the Main Heading, items cost and worth cost is calculated and are tabulated in Table 1.

Table 1 : Expenditure under the Main Heading

Sr. No.	Particulars	Cost in Lakhs	Worth in Lakhs
1	Land	74.31	59.00
2	Leveling and site development	25.00	18.50
3	Factory Office	32.28	12.90
4	Internal Roads	45.44	11.36
5	Compound Wall	39.89	19.94
6	Water and Sewerage Systems	28.00	16.80
7	The Main Factory Buildings		
	1. Sizing/warping/ TFO shade	244.68	224.68
	2. Compression room	41.77	41.77
	3. Boiler house	35.09	35.09
	4. Loom shade	199.54	199.54
	5. Loom plant room	70.80	70.80
	6. Sizing plant room	26.59	26.59
	Subtotal	643.60	623.60
8	Security office,	5.93	0.593
9	Construction of power House	25.13	25.13
10	Canteen and other buildings	19.35	15.48
11	Miscellaneous Civil Engineering Works	25.00	22.5
	Grand Total	938.80	800.67

(Source : Figures of expenditure are collected from site office, as per architect office estimate)

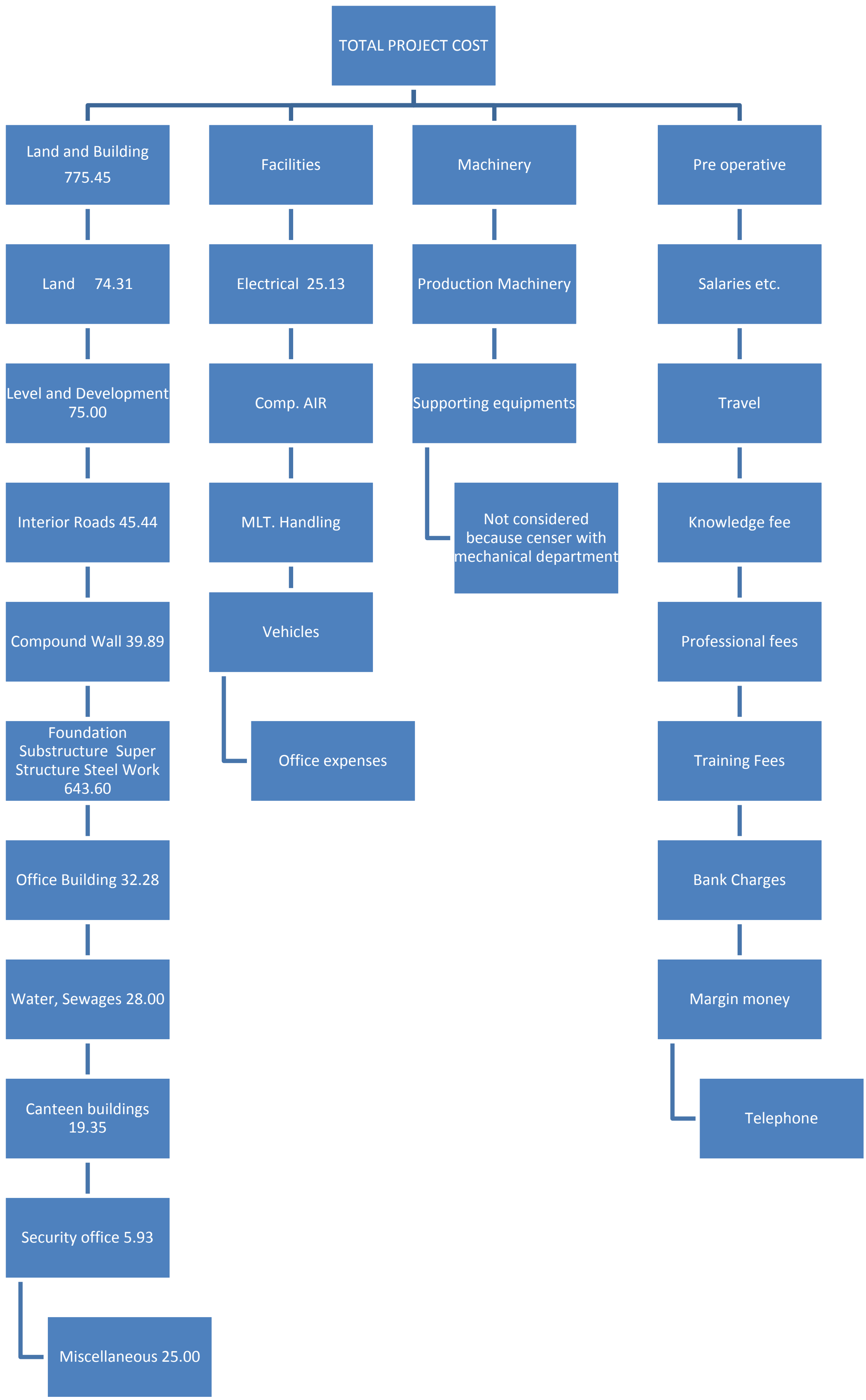

Figure 2 : Construction cost modeling of a new factory building

The project implementation team after collecting the preliminary data whose costs appeared to be too high in relation with the overall project costs and in consideration of their functions and importance prepare a list of such items. Among of those selected items were considered for Value Engineering.

a) Site development
b) Factory office
c) Internal Roads
d) Compound Wall
e) Security
f) Canteen and other buildings.

A team of senior Executives was assembled under the charge of General Manager for CCM, who first identifying their functions, cost and worth. Generating ideas to provide the essential functions in other ways and evaluation of the ideas and short-listing after detailed investigations.
For instance,

- *The function of a Compound Wall was* - to provide privacy, demarcate boundary, prevent trespass, prevent theft, provide aesthetics, and provide security.

A number of ideas were generated in the brainstorming session for providing these functions in other ways and after evaluation and investigation, the team decided to provide a fencing all around, except near the main entrance where the masonry wall was retained as a concession to aesthetics, also the land had been recently acquired in a rural community and the unlikelihood of theft of the heavy and bulky materials, the team identified "demarcate boundary", and "prevent trespass" as the basic functions and the others as secondary. The two different planes and cross section for wall compound is shown in figure 4 (a ,b)The actual cost of the construction is 39.89 but the worth is 19.94 , leading to saving of 19.95 on this account alone.

- The Team decided on the conventional location of the Factory office adjoining the main factory building which was preferred by the operating staff and executives. By this, nearly 34.08 cost of the internal roads and leveling and site development, retaining wall which had been planned earlier could also be reduced, resulting in a saving 6.5 overall.
- In the superstructure, a nearly 3 meter high extension of the side walls had been provided by the architects to hide the saw tooth shape of the roofing as a measure of aesthetics. This was promptly dropped by the team which felt that there was nothing wrong in a factory looking like a factory, thereby saving over 20.0
- Similarly, the project team was able to reduce cost in many other areas with the help of Construction Cost Modeling and successfully completing the project within the budget cost, inspite of steep escalations in the cost of steel and cement.

To derive maximum possible benefits from Value Engineering, it should be introduced and practiced as a systematic and continuing activity in the organization for successful launching by Value Engineering programmers.

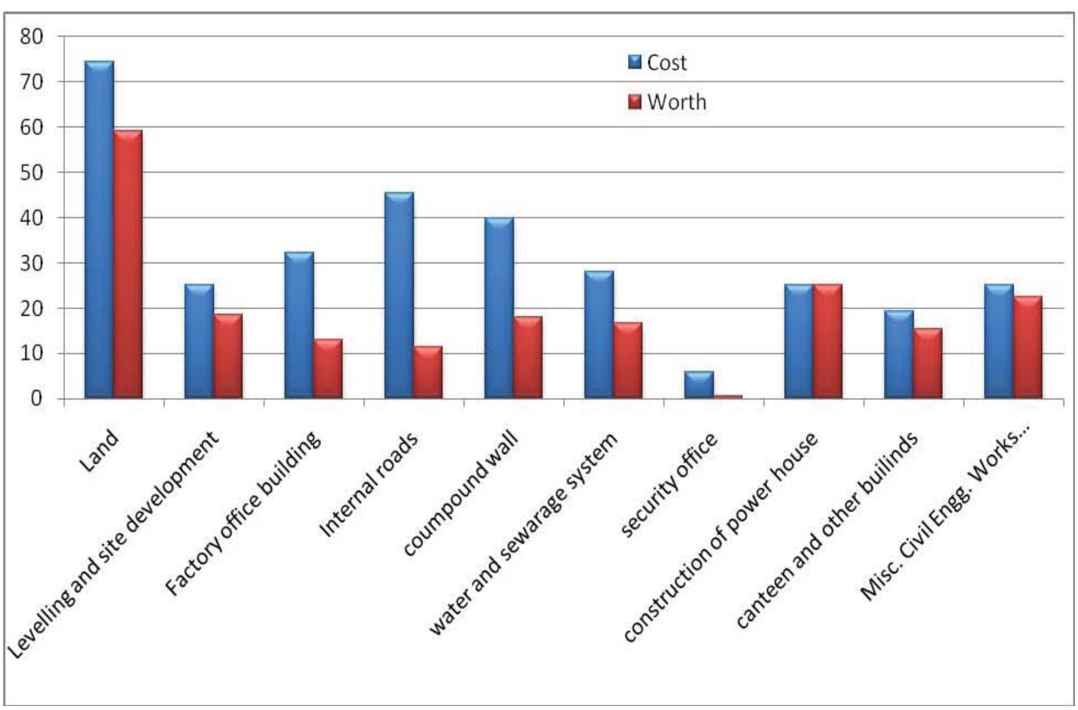

Figure 3 : Graphical representations of Cost and Worth

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VI. Results and Discussion

- Land-Initially the total area of land requirement for the set up of a new factory building is 24.77 Acres, but CCM provide us substantial saving in cost. Minimum 19.67 acres of land is required initially and are purchased which provides sufficient fund saving for other activities .No doughty there is further expansion of factory which requires area of 5.10acres, which can be preached later on stage.
- Leveling and site development - by using CCM it is seen that complete leveling of land is not required for the project, so it is decided to level only the required area of land for project resulting in 25% saving on activity.
- Factory office – for factory office, curtailment of office building is imposed by using CCM technique which reduced the requirement cost by 2 times for office building it suggested a already constructed site office building with addition improvement and alteration.
- Internal Roads –for the transportation purpose and movement of the vehicles internal roads are provided with in the factory premises of cost 45.44 lacks .But to achieve economy and saving in funds for remaining activities, it is decided that only main roads which are 30 % of total road length subjected to heavy loading are constructed with bitumen, and remaining should be of Water Bond Macadamia type.
- Compound Wall –large saving on funds archived by applying CCM technique to compound wall. In this it is suggested to construct a compound wall in two different sections, which are shown at the end of paper. For front side of factory along the road side length section 1 is utilized and for remaining three sides of factory section 2 is suggested, resulting in 50 % saving in original cost.
- Water and Sewerage Systems- It is decided after discussion that only essential part of water supply and sewerage system in initial phase of work which results in 75 % saving on original investment on items.
- Security office- according to CCM technique it is decided to provide security office at the entrance only, using the same infrastruction of entrance gate
- Canteen and other buildings and Miscellaneous Civil Engineering Works -already low budget buildings have been decided to construct so no major cost saving in this items.

VII. Conclusion

CCM technique can be effectively apply to reduced the cost of structure in many of the areas for very large and complex construction whose cost is disproportionally more than considering these functional use or necessary in spite of steep escalation in the cost of steel, cement and over all cost due hike of market prices. The CCM tech was effective implementation for the construction new factory building at Sutrepada, Dhule (Maharashtra) .At eleven (11) different sections major saving in fund was observed total saving in funds was observed to be 111.75 lacks. This indicates the proportion of CCM as effective technique. However draw back of this technique can not be implemented for the section like power house construction.

VIII. Acknowledgement

We acknowledge the chairman Babasaheb K. R Patil along with body members, and M/s Mukesh & Associates, Salem. Chennai India who has prepared the project report based on the technical advice of the foreign collaborators and the estimates prepared by the planning team and Architects.

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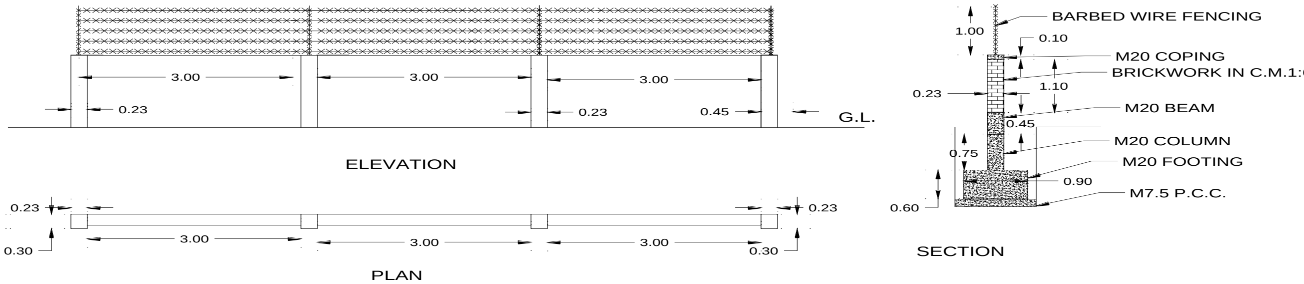


Figure 4a : Plan, elevation and Cross section of wall compound

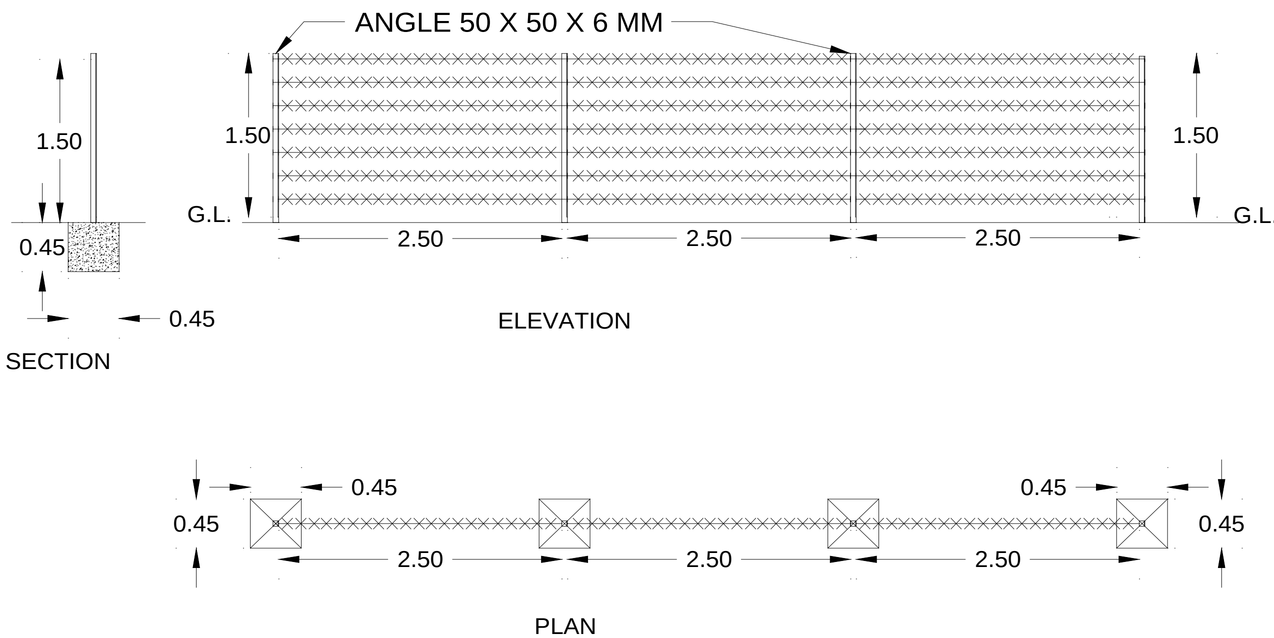
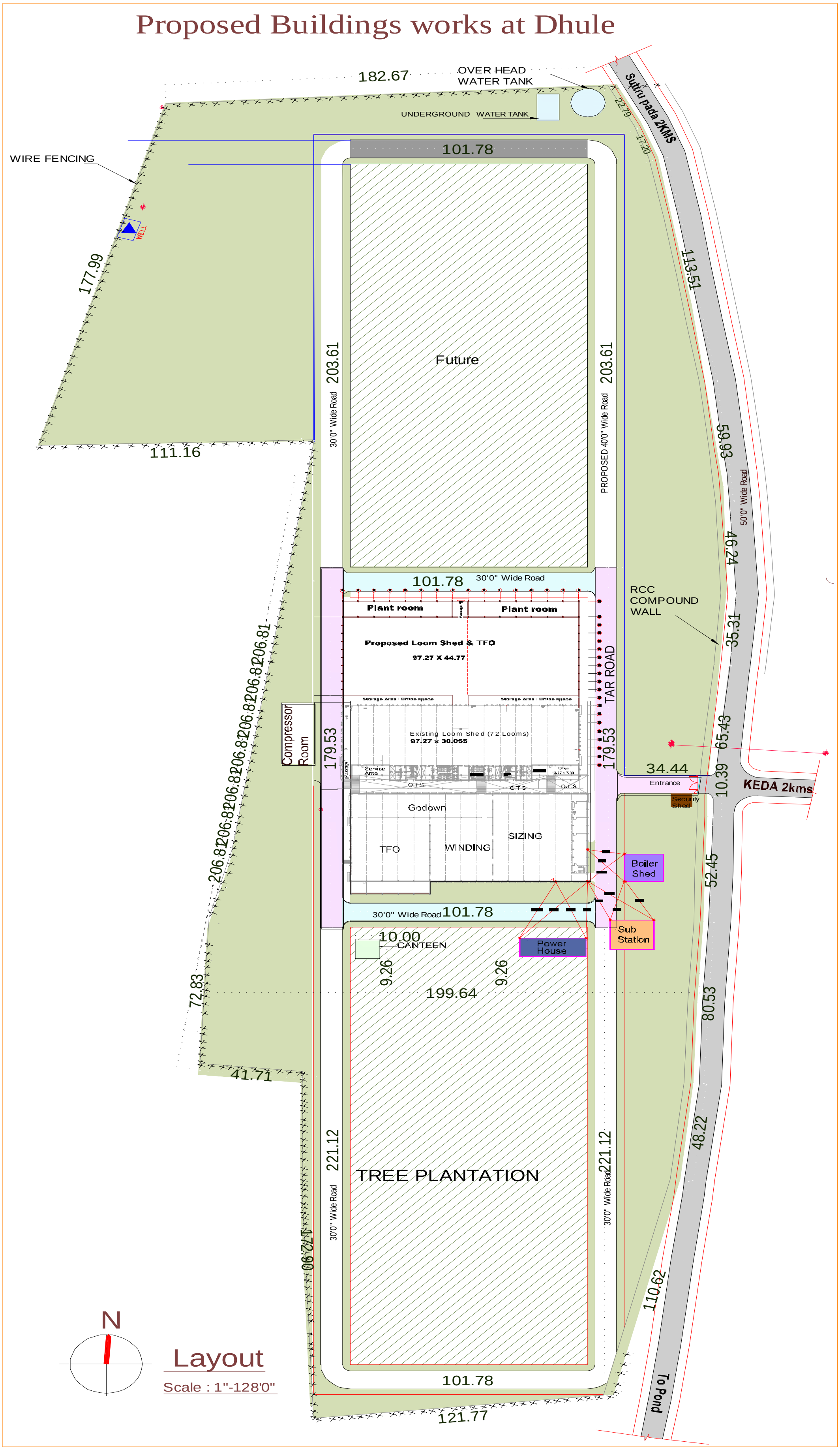


Figure 4b : Plan, elevation and Cross section of wall compound



(Source : Drawing collected from site)

Figure 2 : Layout plan of proposed factory building

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Treatment of Water Drainage for Agriculture

By Professor Kadhim Naief Kadhim Al-Taee
& Basima Abbas Jabir Al-Humairi
University of Babylon, Iraq

Abstract - This research aims to examine the processing water drainage and used for agricultural purposes were used samples of water drainage and mixed with samples of river water at different ratios to get water containing salts proportions few were these samples (drainage and river from region Dujaili / Wasit Governorate) In this research ions were examine (Ca, Na, mg) to find a standard indicator of water quality labeled sodium adsorption ratio (SAR) as well as examine (EC, PH) was the tests in the laboratory of the College of Agriculture / University of Wasit. And compare the results with the system laboratory salinity U. S. (USSL) system and Food Agriculture Organization of the United Nations (FAO). In this study it was found that the proportion mixing (10%drainage + 90%River), (20%drainage + 80%River) is the ratio preferred as well as the more EC increased salt concentration in the water and the pH values of this water was within normal limits.

GJRE-E Classification : FOR Code: 290802

TREATMENTOFWATERDRAINAGEFORAGRICULTURE

Strictly as per the compliance and regulations of :

Treatment of Water Drainage for Agriculture

Professor Kadhim Naief Kadhim Al-Taee [α] & Basima Abbas Jabir Al-Humairi [σ]

Abstract - This research aims to examine the processing water drainage and used for agricultural purposes were used samples of water drainage and mixed with samples of river water at different ratios to get water containing salts proportions few were these samples (drainage and river from region Dujaili / Wasit Governorate) In this research ions were examine (Ca, Na, mg) to find a standard indicator of water quality labeled sodium adsorption ratio (SAR) as well as examine (EC, PH) was the tests in the laboratory of the College of Agriculture / University of Wasit. And compare the results with the system laboratory salinity U. S. (USSL) system and Food Agriculture Organization of the United Nations (FAO). In this study it was found that the proportion mixing (10%drainage + 90%River), (20%drainage + 80%River) is the ratio preferred as well as the more EC increased salt concentration in the water and the pH values of this water was within normal limits.

I. Introduction

Both irrigation water quality and proper irrigation management are critical to successful crop production. The quality of the irrigation water may affect both crop yields and soil physical conditions, even if all other conditions and cultural practices are favorable/optimal. In addition, different crops require different irrigation water qualities. Therefore, testing the irrigation water prior to selecting the site and the crops to be grown is critical. The quality of some water sources may change significantly with time or during certain periods (such as in dry/rainy seasons), so it is recommended to have more than one sample taken, in different time periods. The parameters which determine the irrigation water quality are divided to three categories: chemical, physical and biological. In this review, the chemical properties of the irrigation water are discussed. The chemical characteristics of irrigation water refer to the content of salts in the water as well as to parameters derived from the composition of salts in the water; parameters such as EC/TDS (Electrical Conductivity/ Total Dissolved Solids), SAR (Sodium Adsorption Ratio) alkalinity and hardness. The primary natural source of salts in irrigation water is mineral weathering of rocks and minerals. Other secondary sources include atmospheric deposition of oceanic salts (salts in rain water), saline water from rising groundwater and the intrusion of sea water into groundwater aquifers. Fertilizer chemicals, which leach to water sources, may also affect the irrigation water quality.

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Author σ : Assist. Lecturer/ Technical Institute of Kut.

The main problem related to irrigation water quality is the water salinity. Water salinity refers to the total amount of salts dissolved in the water but it does not indicate which salts are present in High level of salts in the irrigation water reduces water availability to the crop (because of osmotic pressure) and causes yield reduction. Above a certain threshold, reduction in crop yield is proportional to the increase in salinity level. Different crops vary in their tolerance to salinity and therefore have different thresholds and yield reduction rates. *Mohsen Seilsepour and Majid Rashidi (2008):* Studied Modeling of Soil Sodium Adsorption Ratio Based On Soil Electrical Conductivity The statistical results indicated that in order to predict soil SAR based on soil EC, the linear regression model SAR = 1.91 + 0.68 EC with R2 = 0.69 can be recommended,. *Mohsen Seilsepour et. al (2009)* Studied Prediction of Soil Exchangeable Sodium Percentage Based on Soil Sodium Adsorption Ratio The statistical results of the study indicated that in order to predict soil ESP based on soil SAR the linear regression model ESP = 1.95 + 1.03 SAR with R2 = 0.92 can be recommended. *Cannon et al (2004):* studied Measured and Estimated Sodium-Adsorption Ratios for Tongue River and its Tributaries, Montana and Wyoming The Tongue River drains an area of about 5,400 square miles and flows northward from its headwaters in the Bighorn National Forest of northeastern Wyoming to join the Yellowstone River at Miles City, Montana. Water from the Tongue River and its tributaries is extensively used for irrigation in both Wyoming and Montana, and show resulting in a high sodium-adsorption ratio (SAR). Disposal of ground water with high sodium concentrations into the Tongue River has the potential to increase salinity and SAR of water in the river, and potentially reduce the quality of water for irrigation purpose. *Yaohu Kang et.al (2010) :* studies the effects of drip irrigation with saline water on waxy maize and the Results indicated was the irrigation water with salinity <10.9dS/m did not affect the emergence of waxy maize. As salinity of irrigation water increased, seedling biomass decreased, and the plant height, fresh and dry weight of waxy maize in the thinning time decreased by 2% for every 1dS/m increase in salinity of irrigated water. The decreasing rate of the fresh ear yield for every 1 dS/m increase in salinity of irrigation water was about 0.4–3.3% Irrigation water use efficiency (IWUE) increased with the increase in salinity of irrigation water when salinity was <10.9dS/m. *Jamal et, al (2007):* Studied Irrigation Water Quality Evaluation With Special Reference to Wasit Governorate the

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classifications followed were the USSL and FAO systems, and then water suitability for irrigation was evaluated accordingly. The results showed that, all water samples fell within the water class (C3 – S1) according to USSL system. Whereas, in FAO system, the samples fell within the class (increase in salinity hazard) for the salinity hazard; within (no hazard, increase in permeability hazard) for soil permeability based on Eciw and Adj. SAR indicators; within (no hazard and increasing toxicity hazard) for toxicity based on (Na^{+}+Cl^{-}) concentrations; and within (increasing hazard) class for miscellaneous effects of irrigation water based on bicarbonate as showed the high content of (Ca^{+2}+Mg^{+2}) comparatively with Na^{+} ions decrease the hazard of residual bicarbonate (RSC) effects, and hence reduce soil ESP values.

II. Characterizing Salinity

There are two common water quality assessments that characterize the salinity of irrigation water. The salinity of irrigation water is sometimes reported as the total salt concentration or total dissolved solids (TDS). The units of TDS are usually expressed in milligrams of salt per liter (mg/L) of water. This term is still used by commercial analytical laboratories and represents the total number of milligrams of salt that would remain after 1liter of water is evaporated to dryness. TDS is also often reported as parts per million (ppm) and is the same numerically as mg/L. The higher the TDS, the higher the salinity of the water The other measurement that is documented in water quality reports from com mercial labs is specific conductance, also called electrical conductivity (EC). EC is a much more useful measurement than TDS because it can be made instantaneously and easily by irrigators or farm managers in the field. Salts that are dissolved in water conduct electricity, and, therefore, the salt content in the water is directly related to the EC. The EC can be reported based on the irrigation water source (ECw) or on the saturated soil extract (ECe). Units of EC reported by labs are usually in millimhos per centimeter (mmhos/cm) or decisiemens per meter (dS/m). One mmho/cm=1 dS/m. EC is also reported in micrommhos per centimeter (μmhos/cm) (1μmho=1/1000).

Often conversions between ECw and TDS are made, but caution is advised because conversion factors depend both on the salinity level and composition of the water *(Stephen R. Grattan2002)*. For example

$$\text{TDS (mg/L)} = 640 \times \text{ECw (dS/m) when ECw} < 5 \text{ dS/m}$$

$$\text{TDS (mg/L)} = 800 \times \text{ECw (dS/m) when ECw} > 5 \text{ dS/m}$$

Sulfate salts do not conduct electricity in the same way as other types of salts Therefore, if water contains large quantities of sulfate salts, the conversion factors are invalid and must be adjusted upward.

III. Salinity Effects on Crops

The primary objective of irrigation is to provide a crop with adequate and timely amounts of water, thus avoiding yield loss caused by extended periods of water stress during stages of crop growth that are sensitive to water shortages. However, during repeated irrigations, the salts in the irrigation water can accumulate in the soil, reducing water available to the crop and hastening the onset of a water shortage. Understanding how this occurs will help suggest ways to counter the effect and reduce the probability of a loss in yield.

The plant extracts water from the soil by exerting an absorptive force greater than that which holds the water to the soil. If the plant cannot make sufficient internal adjustment and exert enough force, it is not able to extract sufficient water and will suffer water stress. This happens when the soil becomes too dry. Salt in the soil-water increases the force the plant must exert to extract water and this additional force is referred to as the osmotic effect or osmotic potential. For example, if two otherwise identical soils are at the same water content but one is salt-free and the other is salty, the plant can extract and use more water from the salt-free soil than from the salty soil. The reasons are not easily explained. Salts have an affinity for water. If the water contains salt, more energy per unit of water must be expended by the plant to absorb relatively salt-free water from a relatively salty soil-water solution *(Ayers and Westcot 1994)*.

IV. Irrigation Water Quality Criteria

Soil scientists use the following categories to describe irrigation water effects on crop production and soil quality:

- Salinity hazard - total soluble salt content
- Sodium hazard - relative proportion of sodium to calcium and magnesium ions
- pH - acid or basic
- Alkalinity - carbonate and bicarbonate
- Specific ions: chloride, sulfate, boron, and nitrate

a) *pH and Alkalinity*

The acidity or basicity of irrigation water is expressed as pH (< 7.0 acidic; > 7.0 basic). The normal pH range for irrigation water is from 6.5 to 8.4.. High pH's above 8.5 are often caused by high bicarbonate (HCO_3-) and carbonate (CO_3^{2}-) concentrations, known as alkalinity. High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution. As described in the sodium hazard section, this alkaline water could intensify the impact of high SAR water on sodic soil conditions. Excessive bicarbonate concentrates can also be problematic for drip or micro-spray irrigation systems when calcite or scale build up causes reduced flow rates through orifices or emitters. In these situations, correction by injecting sulfuric or other acidic materials into the system may be required. *(Bauder.et.al 2012).*

b) Sodium Hazard

Although plant growth is primarily limited by the salinity (EC_w) level of the irrigation water, the application of water with a sodium imbalance can further reduce yield under certain soil texture conditions. Reductions in water infiltration can occur when irrigation water contains high sodium relative to the calcium and magnesium contents. This condition, termed "sodicity," results from excessive soil accumulation of sodium. Sodic water is not the same as saline water. Sodicity causes swelling and dispersion of soil clays, surface crusting and pore plugging. This degraded soil structure condition in turn obstructs infiltration and may increase runoff. Sodicity causes a decrease in the downward movement of water into and through the soil, and actively growing plants roots may not get adequate water, despite pooling of water on the soil surface after irrigation.

The most common measure to assess sodicity in water and soil is called the Sodium Adsorption Ratio (SAR). *Sodium adsorption ratio (SAR):* is a measure of the suitability of water for use in agricultural irrigation, as determined by the concentrations of solids dissolved in the water. It is also a measure of the *sodicity* of soil, The SAR defines sodicity in terms of the relative concentration of sodium (Na) compared to the sum of calcium (Ca) and magnesium (Mg) ions in a sample *(Bauder.et.al 2012).*

The SAR assesses the potential for infiltration problems due to a sodium imbalance in irrigation water. The SAR is mathematically written below by equation 1, where Na, Ca and Mg are the concentrations of these ions in milliequivalents per liter (meq/L). Concentrations of these ions in water samples are typically provided in milligrams per liter (mg/L). To convert Na, Ca, and Mg from mg/L to meq/L, you should divide the concentration by 22.9, 20, and 12.15 respectively. Table (1)and (2) show limitation for SAR and EC depend for USSL and FAO and figure (1) show the determine SAR from {Na ,Ca ,Mg.}. (هتعامجو ريضخ ماصع)

$$SAR = \frac{Na^{+}{}_{meq/L}}{\sqrt{\dfrac{(Ca^{++}{}_{meq/L}) + (Mg^{++}{}_{meq/L})}{2}}} \qquad (1)$$

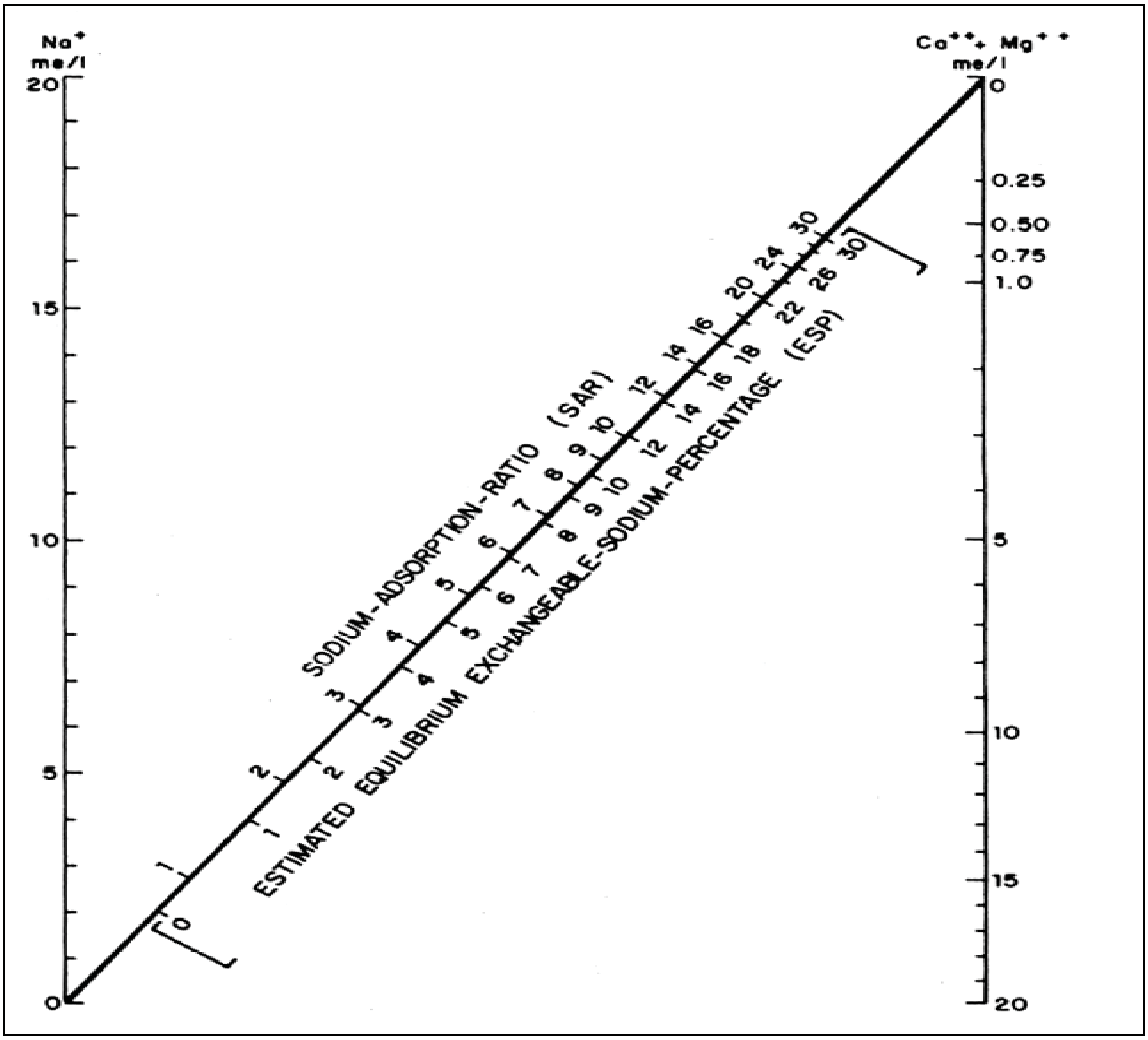

Figure 1 : Show the determining the SAR value of irrigation water

Table 1 : Show the Limit for Electrical Conductivity (EC)

Table (1) show the limit for electrical conductivity (EC)			Table (1) show the limit for electrical conductivity (EC)		
Class	Range (ds/m)	Notes	Class	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
Low	0.25≤	C_1	Excellent	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
Meduim	0.25-0.75	C_2	Good	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
High	0.75-2.25	C_3	Unsuitable	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
Very high	2.25≥	C_4		Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)

Table 2 : Show the Limit for Sodium Adsorption Ratio (SAR)

USSL (Richard) 1954			FAO Ayers and Westcot 1994		
Class	Range (ds/m)	Notes	Class	Range (ds/m)	Notes
Low	<10	S_1	Low	<3	
Meduim	18-10	S_2	Meduim	3-9	
High	18-26	S_3	High	9>	
Very high	>26	S_4			

V. Experimental Work

In this study, bring samples of water drainage and river water taken from the region Dujaili located in Wasit Governorate shown in figure 1, was taking samples during the month of December after it was mixing water drainage with river water at different ratios to get water containing salts proportions few For example, has the mixing process (90% of the river water +10% of the water drainage), as well as mixing (80% of the river water +20% of the water drainage) and also has the mixing process versa where the mixing (90% of the water drainage +10%river water), as well as mixing (80% of the water drainage +20% of the water of the river) as shown in table No. 3. the mixing process was in closed containers and was the tests in the laboratory of the College of Agriculture / University of Wasit. and has the test process for these samples by device flame photometer and devices PH and EC as shown in the figure 2 ,3 ,4 have been conducted I analyzes laboratory for these samples has been tested ions (Na, Ca, Mg) calcium and magnesium were estimated in a manner correction and sodium were appreciated your Flame Photometer, estimated electrical conductivity (EC) and the degree of interaction for sample of water using EC-meter and PH-meter then was calculated value sodium adsorption ratio (SAR) by equation 1.

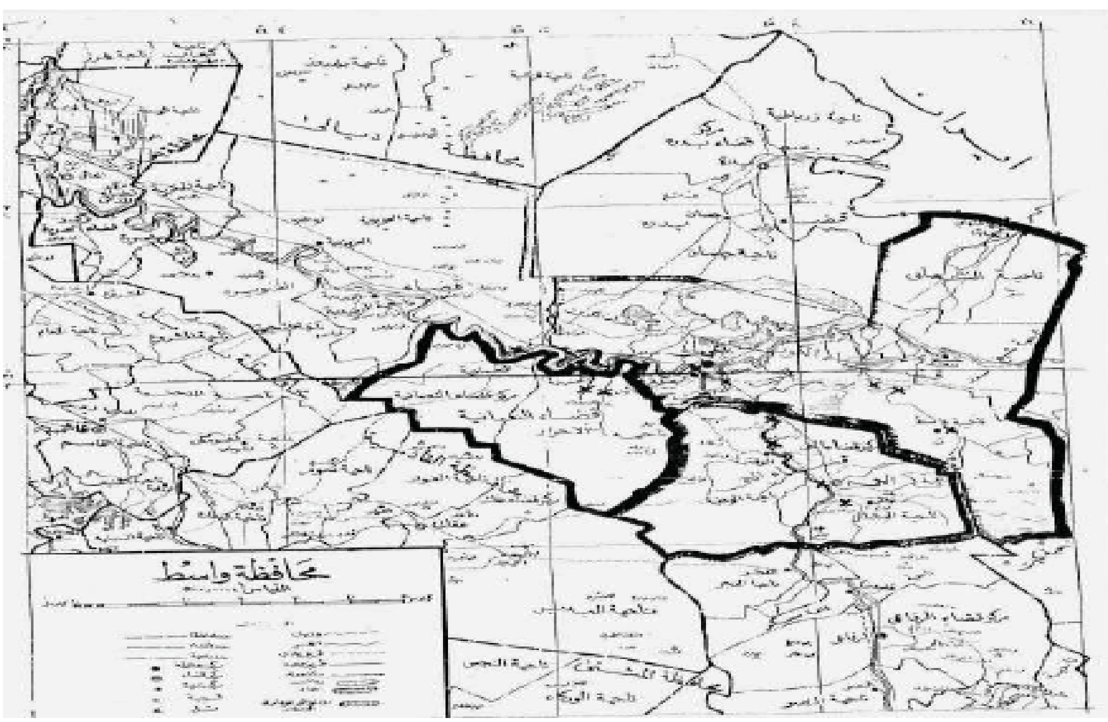

Figure 4 : EC Meter

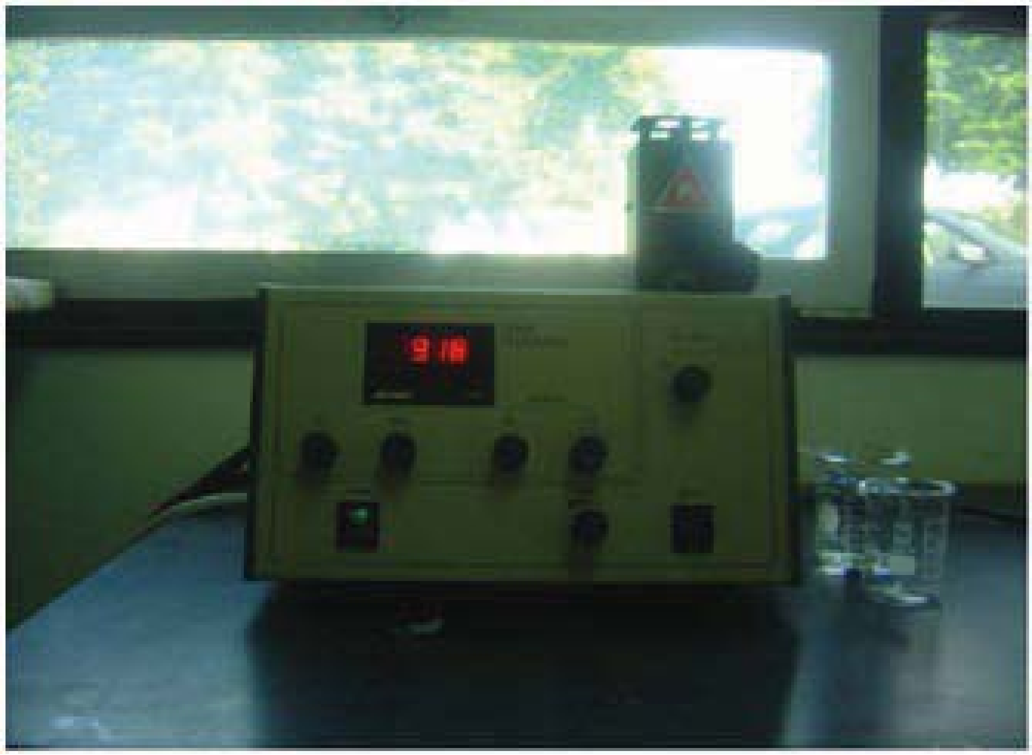

Figure 2 : Device Flame Photometer

Figure 3 : PH Meter

Figure 4 : EC Meter

VI. Results and Discussion

The study results showed that the samples water of percentage (10% drainage + 90% River), (20% drainage + 80% River) located within product (s_1) while water of percentage (30% drainage + 70% River), (40% drainage + 60% River), (80% drainage + 20% River), (70% drainage + 30% River), (60% drainage + 40% River) located within product (s_2) The water of percentage (50% drainage +50% River), (90% drainage + 10% River) located within class (s_3) this is according to the system USSL and FAO. Sample water of percentage (10% drainage + 90% River), (20% drainage + 80% River) incident within class (medium). Other ratios located within the third category (high) these category for SAR as for the electrical conductivity sample water of percentage (10% drainage + 90% River), (20% drainage + 80% River) located within the class (C_3) according USSL system, other percentages and located within the class (C_4) according USSL system either by the FAO system it sample water of percentage (10% drainage + 90% River), (20% drainage + 80% River) 30% drainage + 70% River), (40% drainage + 60% River) located within class good other percentage within third class the result tests for sample of water shown in table 3. Figure (5) show percentage of water drainage and EC. Figure (6) show percentage of water drainage and SAR.

Table 3 : Show the Result Tests for Sample of Water for Different Ratios

No.of sample	Water of river	Water of drainage	Na(meq/L)	Ca+mg(meq/L)	SAR	EC(mmhos/cm)	PH
1	90%	10%	20.07	13	7.87	1.80	7.83
2	80%	20%	28.2	20	8.92	2.10	7.72
3	70%	30%	35.63	17	12.2	2.50	7.4
4	60%	40%	41.46	15	15.13	3.00	7.48
5	50%	50%	44.17	11	18.8	5.50	7.51
6	10%	90%	63	24	18.15	18	7.54
7	20%	80%	57.65	23	17	17.6	7.72
8	30%	70%	52.47	18	17.49	15.6	7.74
9	40%	60%	49.23	17	16.86	14.16	7.68
10	50%	50%	44.17	11	18.8	5.50	7.51
11		Only drainage	69.43	12	28.33	19	7.64
12	Only river		4.96	10	2.21	1.19	7.88

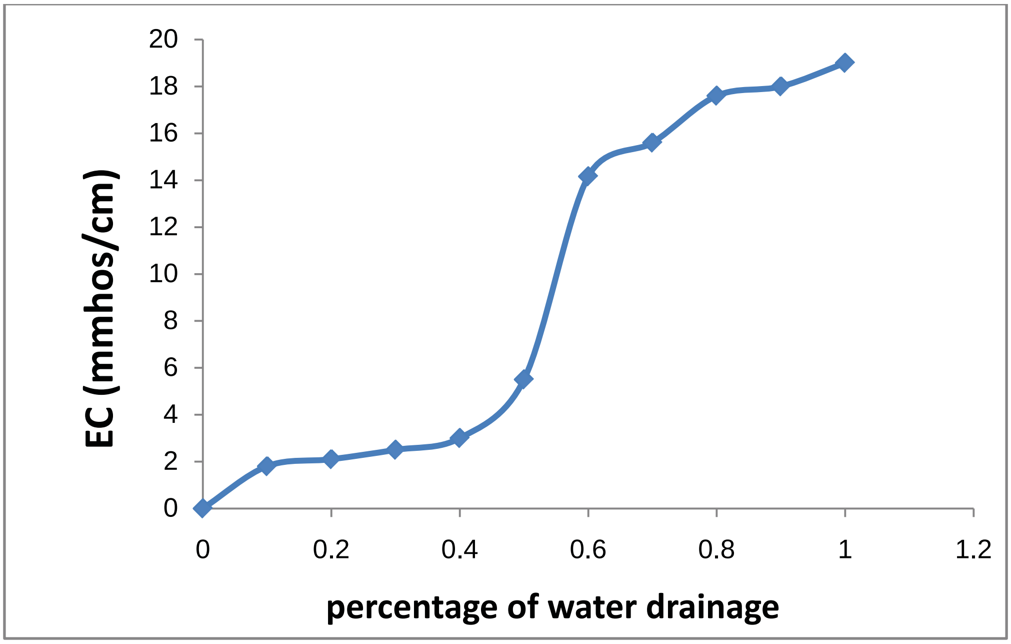

Figure 1 : show percentage of water drainage and EC

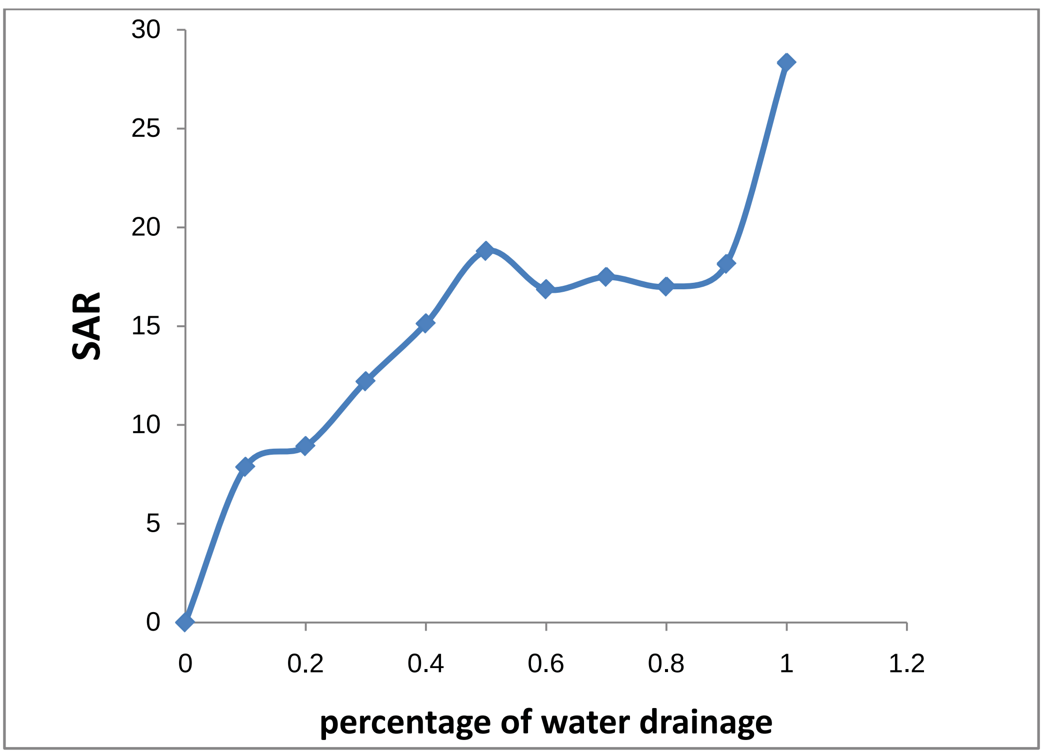

Figure 2 : show percentage of water drainage and SAR

VII. Conclusions and Recommendations

- The increased electrical conductivity lead to increased salt concentration in the water.
- The interaction pH values ranging between (7.40-7.88).
- Results were compared with laboratory salinity U.S (USSL). and Food Agriculture Organization of the United Nations (FAO) and found that the ratio favorite mixing process is (10%drainage +90% River) and (20 %drainage +80% River) located within ((S1-C3) according to the classification laboratory salinity U.S. While according to the

(FAO) the sodium adsorption ratio incident within class (medium) and the electrical conductivity sample located within class good.

- That determine the validity of water for irrigation and agriculture to not depend only on a laboratory tests for irrigation water, but must study other factors affecting determine the validity of water for irrigation and agriculture, including soil (determine characteristics of physical and chemical), type of crop grown and the bear saline, and climatic conditions include temperature, amount of precipitation rainfall, wind speed, the speed of evaporation, etc.) and management irrigation and drainage in terms of the availability of networks and appropriate irrigation techniques and good and effective drainage networks.

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Fellows

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (FARSE)

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- The "FARSE" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSE or William Walldroff, M.S., FARSE.

FARSE accrediting is an honor. It authenticates your research activities. After recognition as FARSE, you can add 'FARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSE designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

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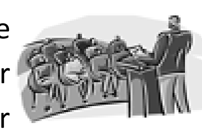

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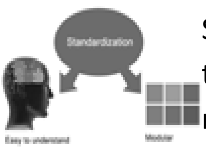

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MARSE accrediting is an honor. It authenticates your research activities. After becoming MARSE, you can add 'MARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

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The MARSE member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

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The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.
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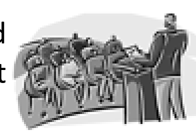

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

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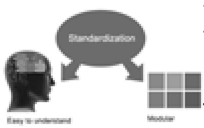

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

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Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

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(II) Choose corresponding Journal.

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

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To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

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Based on potential and nature, the manuscript can be categorized under the following heads:

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Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

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The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

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(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

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(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

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Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

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A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

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- One should avoid outdated words.

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Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

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.

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	A-B	**C-D**	**E-F**
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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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