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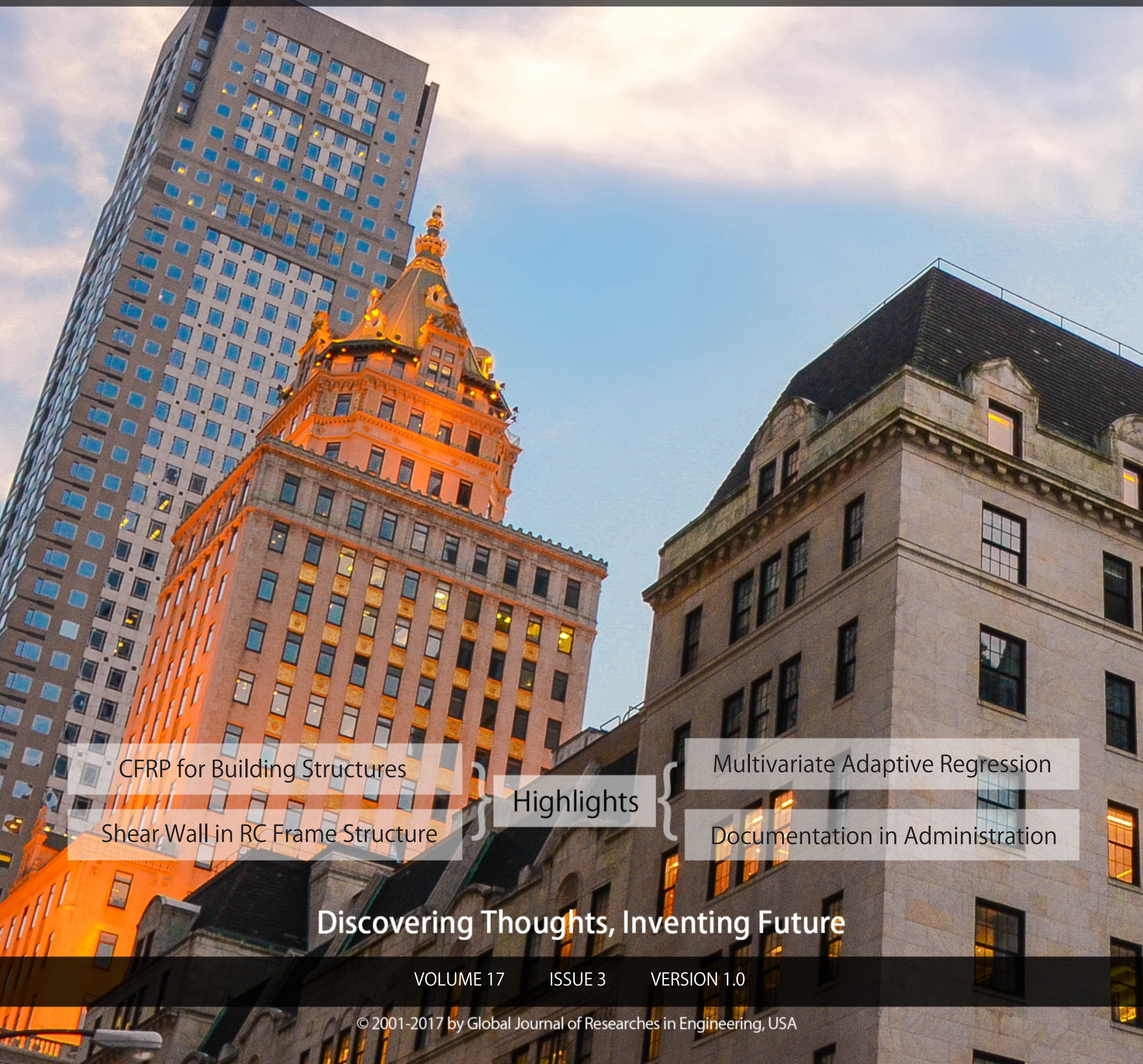

Highlights

- CFRP for Building Structures
- Shear Wall in RC Frame Structure
- Multivariate Adaptive Regression
- Documentation in Administration

Discovering Thoughts, Inventing Future

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Prestressed Concrete Inverted Tee Beams with CFRP for Building Structures

By Herish A. Hussein & Zia Razzaq
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Abstract- Presented herein is the outcome of a study of prestressed concrete inverted tee beams with carbon fiber reinforced polymer (CFRP) sheets for possible use in building structures. To determine an effective approach for the use of CFRP, nine different retrofitting schemes are investigated for a prestressed beam under quasi-static distributed load to increase flexural strength. The theoretical analysis is based on coupling moment-curvature relations with a central finitedifference formulation. Three different thicknesses of CFRP sheets are studied in both tension and compression and effective retrofitting schemes are identified.

Keywords: CFRP retrofitting, inverted tee beam, prestressed.

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Prestressed Concrete Inverted Tee Beams with CFRP for Building Structures

Herish A. Hussein [α] & Zia Razzaq [σ]

Abstract- Presented herein is the outcome of a study of prestressed concrete inverted tee beams with carbon fiber reinforced polymer (CFRP) sheets for possible use in building structures. To determine an effective approach for the use of CFRP, nine different retrofitting schemes are investigated for a prestressed beam under quasi-static distributed load to increase flexural strength. The theoretical analysis is based on coupling moment-curvature relations with a central finite-difference formulation. Three different thicknesses of CFRP sheets are studied in both tension and compression and effective retrofitting schemes are identified.

Keywords: CFRP retrofitting, inverted tee beam, prestressed.

I. Introduction

The effectiveness of CFRP retrofitting when used only in tension zone of prestressed concrete beams has been reported in the past[1-8]. The use of CFRP is beneficial due to it's high strength, light weight, non-corrosive nature, and easy installation. [9] Hussein and Razzaq [10] have previously published a study of prestressed concrete box girders with CFRP retrofitting in both tension and compression for use in highway bridges. Presented in this paper is a study of the effectiveness of CFRP sheets in increasing strength and decreasing deflection when used not only in tension but also in compression, or in both tension and compression regions for prestressed concrete inverted tee beams in buildings.

II. Problem Statement

A prestressed concrete inverted tee beam is shown in Figure 1 carrying a distributed load in addition to it's self-weight of 0.45 kips/ft. Figure 2a shows the inverted tee beam cross section without retrofitting. Figures 2b through 2d show the beam cross section retrofitted with single CFRP sheet in tension only, compression only, and simultaneously in both tension and compression, respectively. The CFRP sheet is 1/16 in. thick with a constant width of 11in. The same retrofitting approaches are repeated with doubling and tripling the CFRP sheets as shown in Figures 2e-2g and 2h-2j, respectively. Each beam has eight 7-wire ASTM Grade 270 ½ diameter strands in one row as shown.

The following non-linear stress-strain (f versus ϵ_c) relationship for concrete given by Lin and Burns [11] is adopted for the present study:

$$f_c = f_c^{'}[2(\epsilon_c/\epsilon_\circ) - (\epsilon_c/\epsilon_\circ)^2] \quad (1)$$

where $f_c^{'}$ is the ultimate compression strength at concrete strain $\epsilon_\circ$. The concrete use d in this study has an ultimate strength of 8 ksi and a Young's Modulus of 5148 ksi. Furthermore, the CFRP sheet used has an ultimate tensile rupture strength of 260 ksi and a Young's Modulus of 22000 ksi. The stress-strain relation for CFRP in compression is nearly the same as in tension. An elastic-plastic stress-strain relation is adopted for prestressing steel. The problem addressed in this paper is the identification of effective CFRP retrofitting schemes that can practically be utilized for prestressed concrete inverted tee beams in building structures. This is achieved by first developing nonlinear moment-curvature (M-ϕ) relations for cross sections shown in Figure 2 followed by the formulation of a numerical scheme to predict the load-deflection response of the beam shown in Figure 1 up to collapse.

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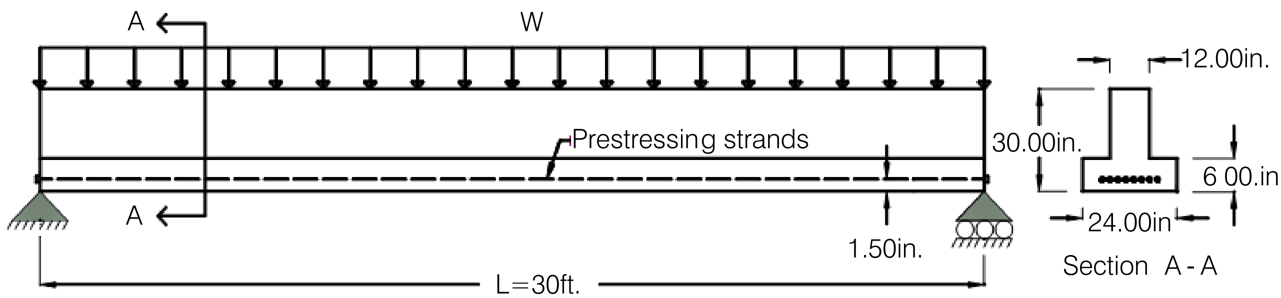

Figure 1: Prestressed concrete inverted tee beam and it's cross section

III. Nonlinear Solution Procedure

The prestressing strands have a prestress force of 160 kips after prestress losses. Figure 3 shows a typical prestressed beam and strain distribution as well as the associated concrete compressive stress distribution and internal force resultants. The resultant forces are Cc,Tps, and TCFRP representing, respectively, concrete compression force, prestressing force, and CFRP tensile force. The equation of the resultant force on the compressed concrete and it's distance X from the neutral axis are given by [11]:

$$C_c = b \times c^2 \times f_c' \times \frac{\phi}{\epsilon_\circ} (1 - \frac{\phi \times c}{3\, \epsilon_\circ}) \quad (2)$$

$$X = c\left(\frac{8\, \epsilon_\circ - 3\, \phi \times c}{12\, \epsilon_\circ - 4\, \phi \times c}\right) \quad (3)$$

where:
b= cross-sectional width at the top,
c= neutral axis distance as shown in Figure 3b, and
ϕ = curvature.

Various loading stages are used to generate the moment-curvature relations. The loading stages are zero external moment, zero strain in concrete at the center of the strands, cracking moment, and the concrete strain reaching 0.001, 0.002, 0.00248, and 0.003 in./in. Elastic bending stress and axial stress equations are used for analysis until the cracking moment is achieved. For the non-linear range, force equilibrium is satisfied after assuming top fiber strain and then iteratively finding the neutral axis location that is, the distance c. The moment and curvature values are then calculated and used to generate themoment-curvature relations for each beam section shown in Figure 2. For the retrofitting schemes with single, double, and triple CFRP sheets in tension, compression, and in both tension and compression, the moment-curvature (M-ϕ) relationships developed are presented in Figures 4,5, and 6, respectively. Next, the moment-curvature relationships are curve-fitted using Excel for each of the beam sections shown in Figure 2. For all of the non-retrofitted and retrofitted schemes, the following equation is established for the materially linear range:

$$\phi = (0.0005M - 1.2) \times 10^{-5} \quad (4)$$

For the nonlinear portion, the following M-ϕ equations are developed for sections shown in Figures 2a through 2j, respectively:

$$\phi_a = (0.008 \times e^{0.001M}) \times 10^{-5} \quad (5)$$

$$\phi_b = (0.0000006M^2 - 0.005M + 9.54) \times 10^{-5} \quad (6)$$

$$\phi_c = (0.007 \times e^{0.001M}) \times 10^{-5} \quad (7)$$

$$\phi_d = (0.0057M - 32.56) \times 10^{-5} \quad (8)$$

$$\phi_e = (0.0000002M^2 - 0.0003M - 2.61) \times 10^{-5} \quad (9)$$

$$\phi_f = (0.0038 \times e^{0.0011M}) \times 10^{-5} \quad (10)$$

$$\phi_g = (0.0000001M^2 + 0.001M - 4.6) \times 10^{-5} \quad (11)$$

$$\phi_h = (0.0000001M^2 + 0.0006M - 4.26) \times 10^{-5} \quad (12)$$

$$\phi_i = (0.0023 \times e^{0.0011M}) \times 10^{-5} \quad (13)$$

$$\phi_j = (0.0026M - 14.5) \times 10^{-5} \quad (14)$$

It should be noted that the last pointon the M-ϕrelations for beam sections 2c, 2f, and 2i are excluded in the above M-ϕ equations. However, the excluded points are separately included when determining the load-deflection relations.

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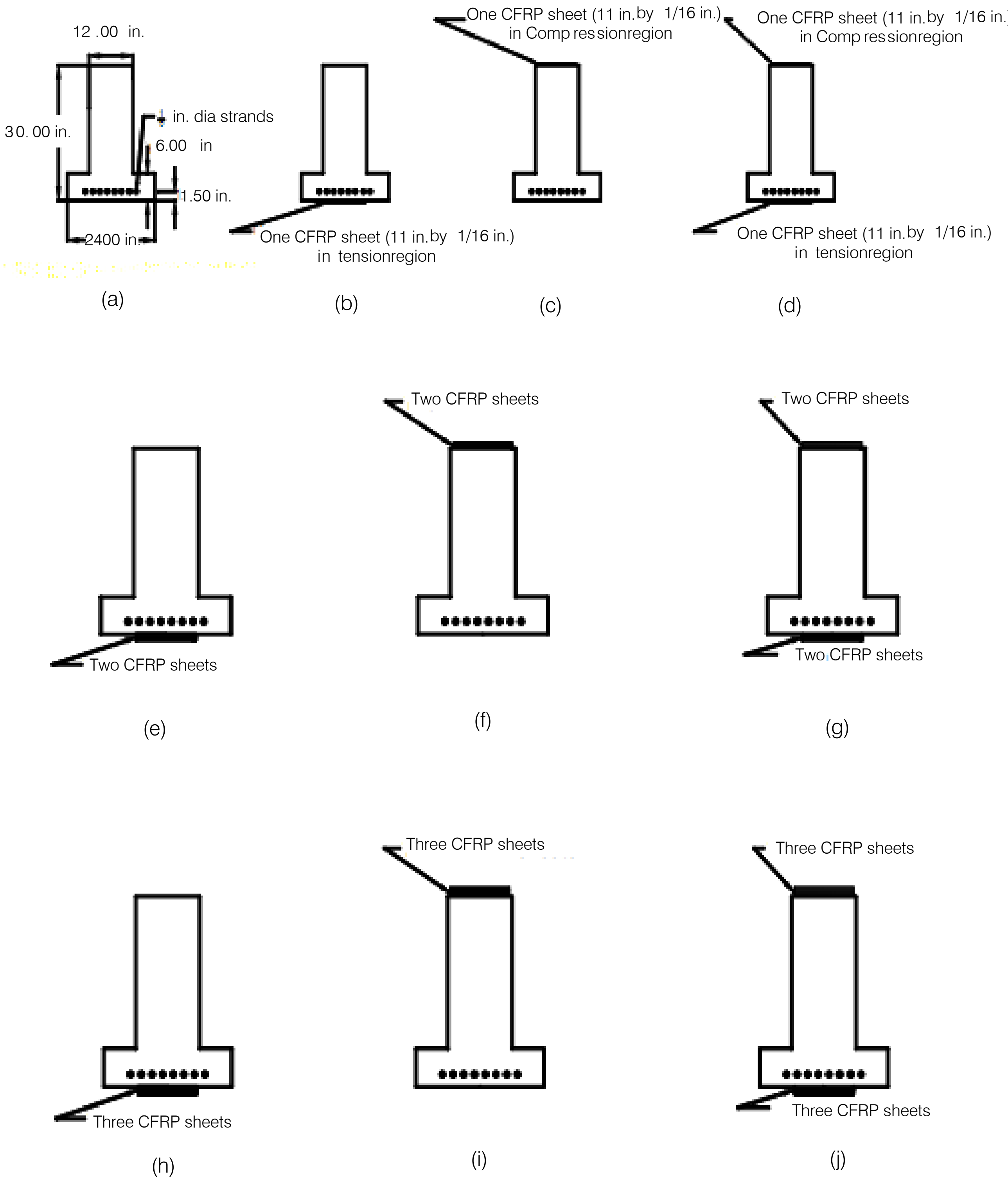

Figure 2: Reference Inverted Tee beam section (a), and various CFRP retrofitting-approach sections (b) through (j)

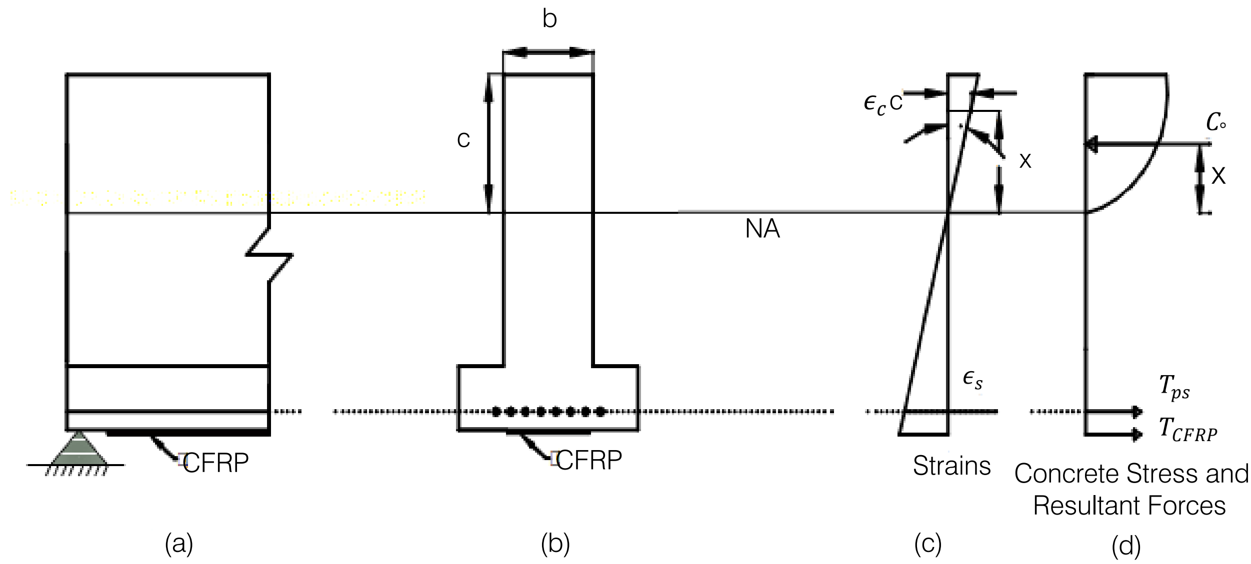

Figure 3: Strain and stress distribution for a simply-supported beam from Figure 2b

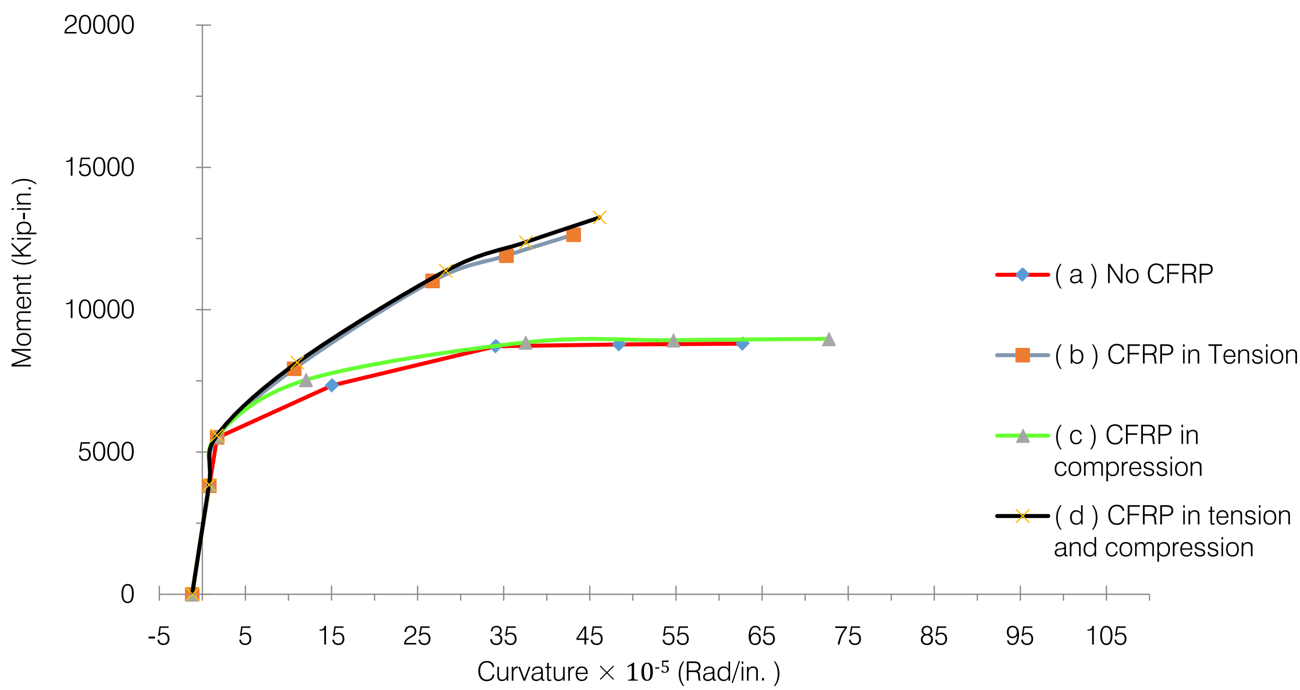

Figure 4: Moment-curvature curves for sections in Figures 2a-2d

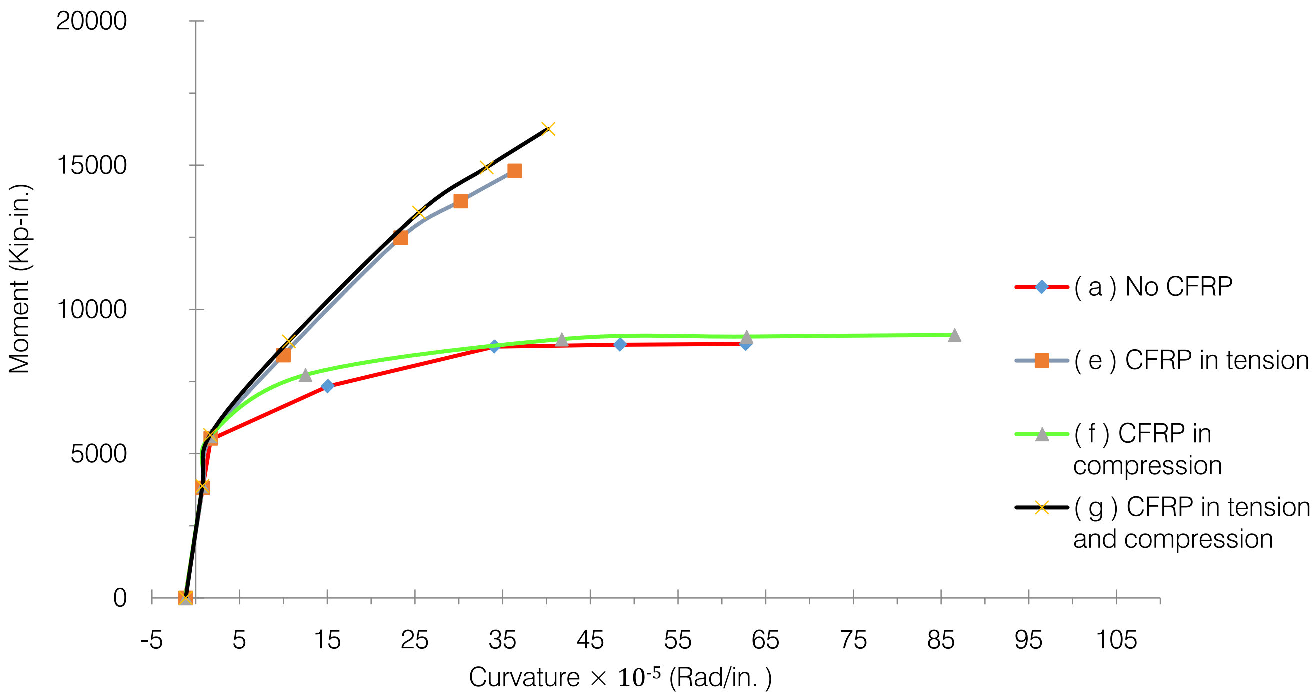

Figure 5: Moment-curvature curves for sections in Figures 2a and 2e-2g

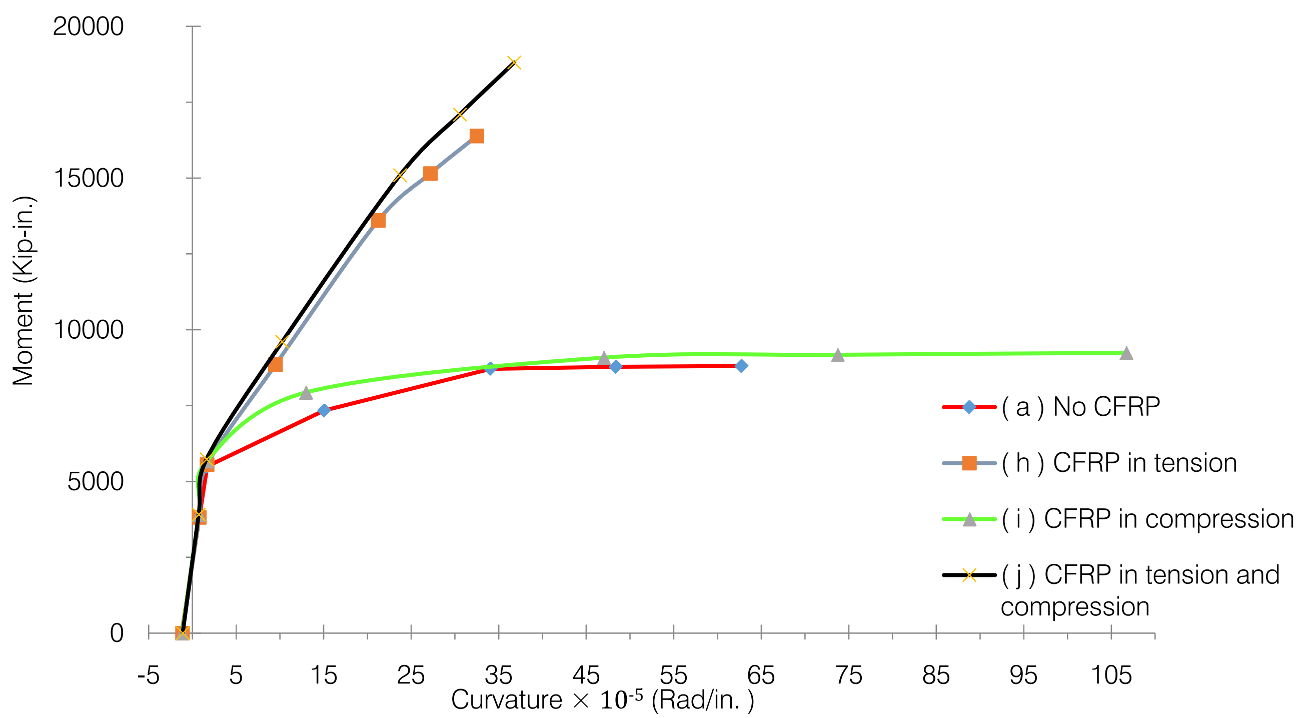

Figure 6: Moment-curvature curves for sections in Figures 2a and 2h-2j

To determine the load-deflection relation for each scheme, the M-ϕrelations are coupled with a central finite-difference algorithm similar to that used by the authors[10].For the present study, the beam is divided into ten equal segments (h=L/10), and the curvature at any given node i along the beam length is expressed as[12]:

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$$\phi_i = \left(\frac{d^2 v}{dz^2}\right)_i = \frac{V_{i-1} - 2V_i + V_{i+1}}{h^2} \qquad (15)$$

where:

Vi= deflection at beam nodei.

To calculate the external moment value at any node for various applied loads, the following equation is used:

$$M_z = [(w\times L\times z) - (w\times z^2)]/2 \qquad (16)$$

where z is the beam longitudinal axis.

The nonlinear solution algorithm predicting the beam response are as follows:

1. Specify beam length L, cross-sectional dimensions, and material properties for concrete, prestressing strands, and CFRP sheets.
2. Divide the beam into N equal segments along the longitudinal axis associated with node numbers i= 1, 2, 3, …, (N+1) over the domain $0\leq z \leq L$.
3. Specify external load w = w1.
4. Determine Mz using Equation 16 at all nodal locations.
5. With Mz values from step four, determine ϕiusing the applicable Equation 4-14.
6. Using Equation 15, generate the following matrix equation to determine nodal deflections, Vi:

$$[Q]\{Vi\}=\{\phi i\} \qquad (17)$$

7. Solve Equation 17 for the nodal deflection vector {Vi}.
8. Increase w to w2 that is, set w2 = w1 +Δw and go to step 4.
9. Repeat until the load-carrying capacity is reached corresponding to the collapse condition.

Using the above algorithm, load versus mid-span deflection, V6, are predicted and are presented in Figures 7, 8 and 9 for CFRP retrofitted beam sections of 2b-d, 2e-2g, and 2h-2j respectively.

IV. Numerical Study

Figure 10 compares the maximum moment versus CFRP thickness relations when CFRP is used in tension only to the schemes in which CFRP is used simultaneously in both tension and compression. A comparison of the two curves in this figure reveals that using CFRP in both tension and compression has a greater effect on increasing the moment capacity compared to the scheme involving retrofitting as the tensile side only.

For the presented study, Table 1 presents a summary of the various retrofitting schemes. Presented in this table are the neutral axis location c, the collapse load wmax, and the increase in wmax, w*.

As can be seen from Table 1, the most effective retrofitting scheme is when three CFRP sheets are simultaneously used in both tension and compression. This scheme (section 2j) resulted in a strength of 2.22 times that obtained with the reference beam (section 2a). The remaining retrofitting schemes are found to be from 1.02 to 1.92 times stronger than the reference beam.

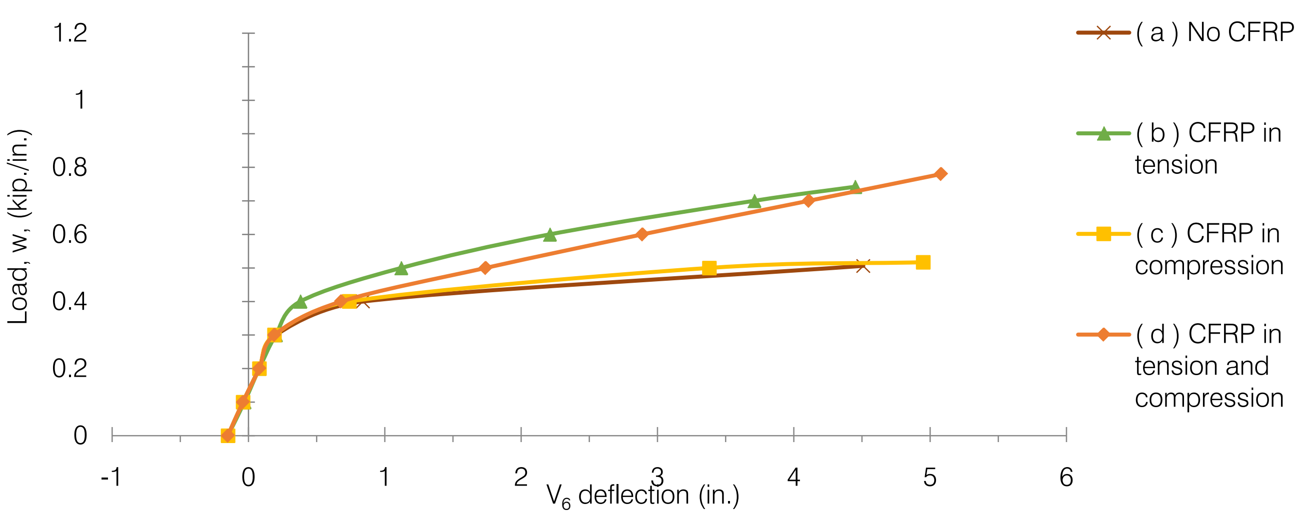

Figure 7: Load-deflection curves for sections in Figures 1a-1d

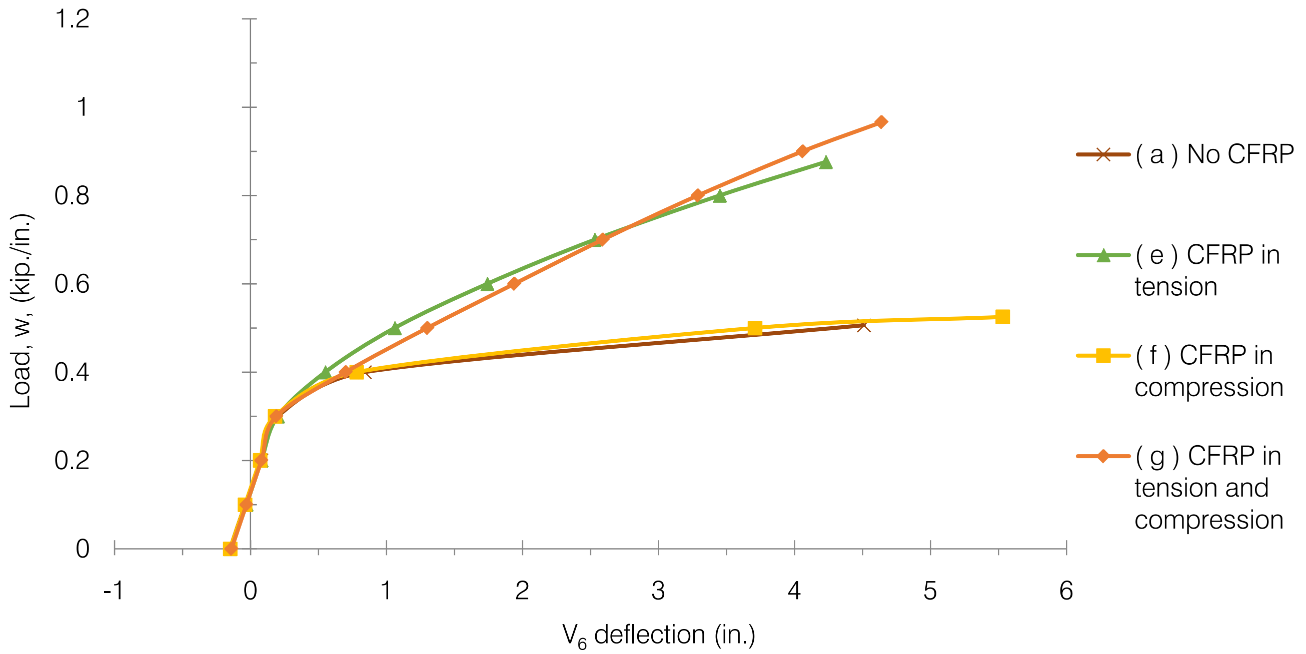

Figure 8: Load-deflection curves for sections in Figures 1a and 1e-1g

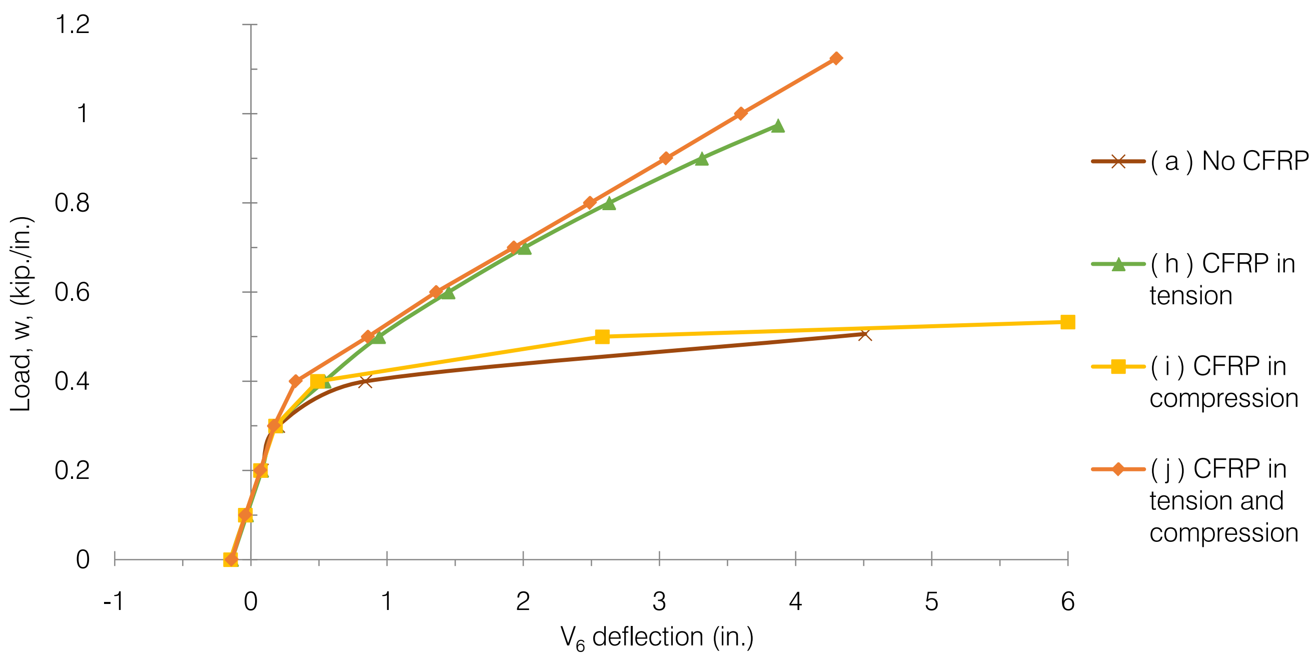

Figure 9: Load-deflection curves for sections in Figures 1a and 1h-1j

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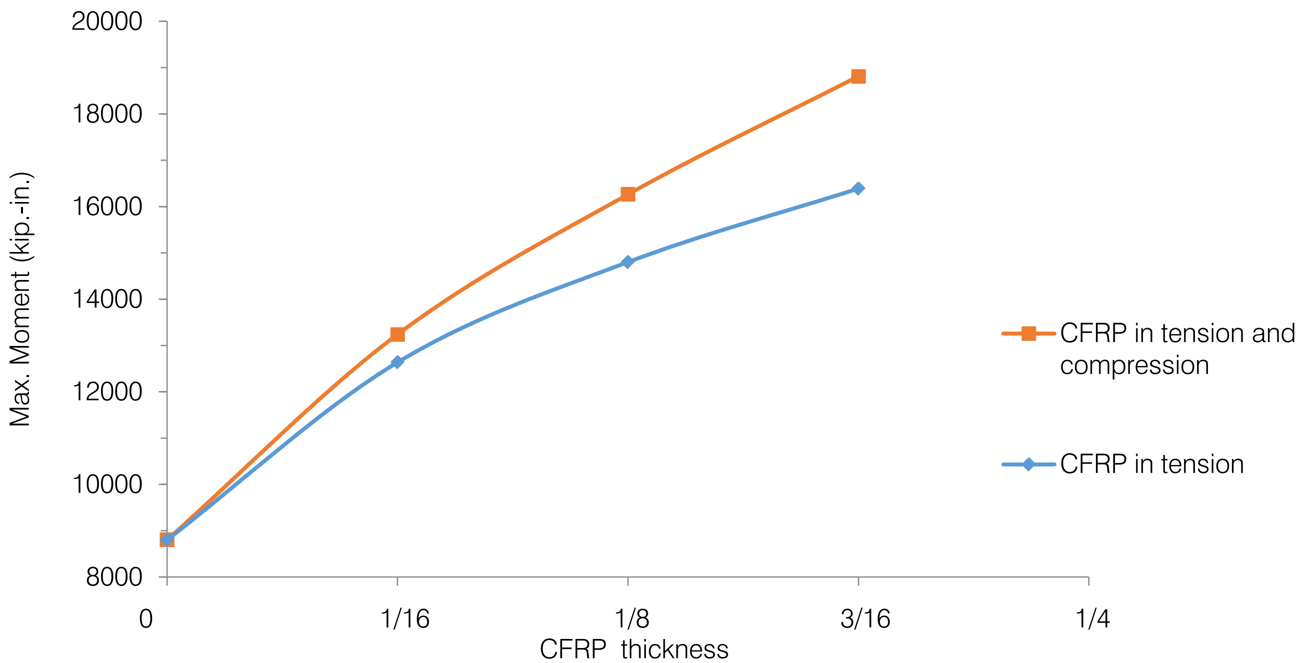

Figure 10: Maximum moment versus CFRP thickness

Table 1: Summary of inverted tee beam results at w_{max}

Section (Figure 2)	c (in.)	w_{max} (kip./in.)	$w^* = w_{max}/0.506$
2a	4.78	0.506	1
2b	6.96	0.742	1.47
2c	4.12	0.517	1.02
2d	6.51	0.780	1.54
2e	8.25	0.876	1.73
2f	3.47	0.525	1.04
2g	7.46	0.966	1.91
2h	9.23	0.974	1.92
2i	2.81	0.533	1.05
2j	8.16	1.124	2.22

V. CONCLUSIONS

Based on the various CFRP retrofitting schemes studied in this paper, the following principal conclusions are drawn:

1. Developing upon the desired degree of increase in the load-carrying capacity of a prestressed inverted tee beam, are more of the retrofitting schemes considered in this paper can be utilized.
2. The simultaneous use of CFRP retrofitting on both tension and compression is the most effective of the retrofitting schemes considered in this paper.
3. The most effective retrofitting schemes investigated herein result in a very significant reduction in the beam deflection.

The results presented in this study can possibly be implemented in practical CFRP retrofitting issues, related to prestressed inverted tee beams in building structures.

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An Investigation of the Effects of Procurement Methods on Project Delivery in the Zambian Road Sector

By Sundie Silwimba & Dr. Balimu Mwyia
University of Zambia

Abstract- The European Union (EU) notes that the construction industry is overwhelmed with variant procurement methods and as such, it is very difficult to check irregularities and checks for compliance. The construction industry further faces challenges in coming up with a suitable method of procuring and delivering a project need. In the Zambian Road Sector (ZRS), there is no consistency in the procurement method used to determine the successful or failure of project delivery. There are various procurement methods being used but the project delivery methods commonly used are the traditional project delivery method and design and build methods.

The aim of the research was to investigate the effects of procurement methods on project delivery in the ZRS. Primary data was obtained using structured questionnaires and interviews. The study used seventy (70) respondents who were experts in procurement and road construction project management in the ZRS.

Keywords: procurement methods, project delivery, zambian road sector, construction industry and procuring guidelines.

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Sundie Silwimba [α] & Dr. Balimu Mwyia [σ]

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The findings revealed that the ZRS is governed by the Zambia Public Procurement Authority's Public Regulations and guidelines, Act of 2008. The other procurement guidelines which are also used in the ZRS are World Bank procurement guidelines for loans and borrowers and the European Union (EU) procurement guidelines. On the other hand, critical procurement factors that affect project delivery were; release of project funds, procurement guidelines, project procurement management training, working capital and presence of a monitoring and evaluation (M&E) unit. It was found that there was no major relationship between the performance of past projects and the procurement methods used. To the contrary it was established that there was a strong relationship between the procurement factors and the project delivery methods used in the ZRS. It is therefore recommended that project funds should be released on time for road projects to be successfully implemented in the ZRS industry as well as embracing best global procurement methods, regulation guidelines and project delivery methods.

Keywords: procurement methods, project delivery, zambian road sector, construction industry and procuring guidelines.

I. Introduction

In Zambia, procurement methods employed to award a contract opportunity to a contractor or consultant for the supply of goods, public works and services in the construction industries include but are not limited to: international open bidding (IOB), national open bidding (NOB), open selection (OS); limited bidding (LB); limited selection (LS); simplified bidding (SB); direct bidding (DB); force account (FA), public private partnership (PPP) and contractor facilitated initiative (CFI) model (Zambia Public Procurement Act, 2011).

With the foregoing, when government agencies, multilateral development banks and public private institutions are overwhelmed with a variety of choices to make in deciding which procurement methods to use, it becomes a challenge, to come up with a suitable method. The challenge lies in the fact that for example in the execution of engineering project works, planning for the unforeseen is usually a standard practice. Therefore, it is very difficult to ultimately foretell at project inception stage the probable risks of using one type of procurement method against the other (Chartered Institute of Buildinga, 2010).

II. Statement of the Problem

In 2011, the government of the republic of Zambia (GRZ), through the road development agency (RDA) unveiled an ambitious road programme, in a bid to open up the country and spur socio-economic development. The notable road programmes introduced among others into the road sector annual work plan (RSAWP), were the link Zambia (LZ) 8000 and Pave Zambia (PZ) 2000 road programmes (Road Development Agency, 2015).

The LZ 8000 programme involves the construction to bituminous standard of 8000 kilometre roads within the core road network (CRN) of Zambia in order to connect strategic provinces, districts and villages within the country. The target group in this programme are high-tech road contractors, consultants, skilled personnel with a few unskilled workers. While the PZ 2000 programme is aimed at constructing and paving 2000 kilometres of low volume roads using paving bricks, in urban areas throughout Zambia. The PZ programme being a labour based intensive programme has an emphasis on the utilization of local resources such as labour and materials. The project was intended to employ youths and reduce high unemployment levels in the country among the youths and also encourage small scale enterprises (SMEs)

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through procurement of concrete paving bricks from various suppliers for the programme (Road Development Agency, 2015).

A glance at the performance of the programme from 2012 to 2016 indicated that out of the 27 projects totalling 4,168.39 kilometres under the LZ 8000 project that commenced, only 692.83 kilometres was opened to traffic as at December 31, 2016.

To help investigate the inter-play between procurement of road projects and successful project delivery, eight (08) projects from the Link Zambia 8000 programme were sampled. The project location covers the whole country of Zambia as shown in figure 1. Being a landlocked nation, the idea was to make Zambia a land linked country with the implementation of the link Zambia 8000: By connecting strategic Provinces; Districts; Suburbs and villages in order to spur socio-economic development.

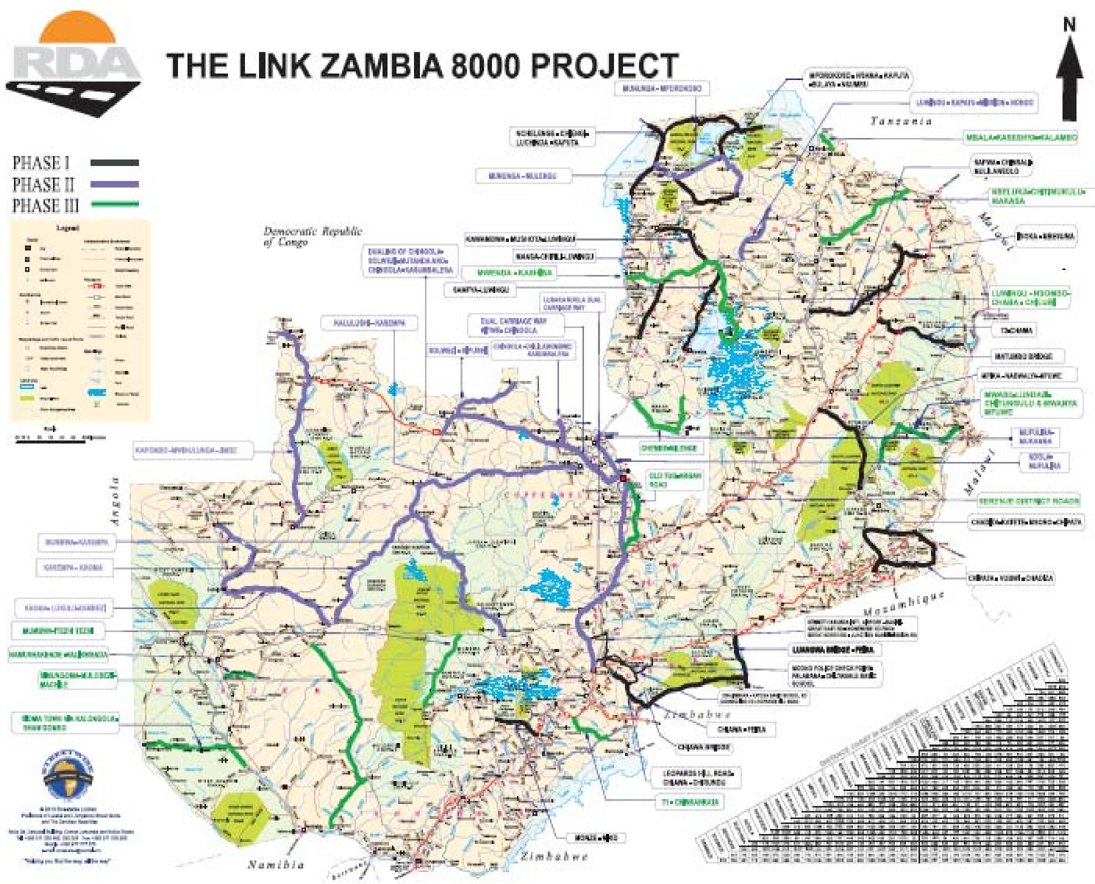

Fig. 1: Description of unveiled roads to be worked on under the Link Zambia 8000

The overall project performance of past road projects in the Zambian road sector stood at 53 percent as shown in figure 2.

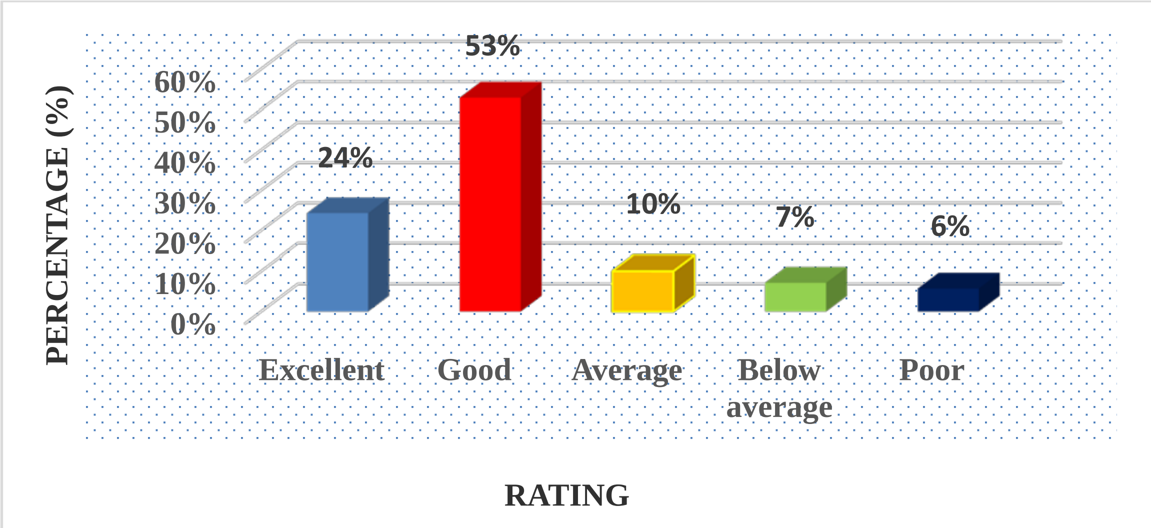

Fig. 2: Showed the overall performance of projects under the Link Zambia 8000

III. Objectives

A. To investigate the effects of procurement methods on project delivery in the Zambian road sector.

IV. Literature Review

Procurement is defined as "a business management function that ensures identification, sourcing, access and management of the external resources that an organization need or may need to fulfil its strategic objectives" (CIPS, available at www.cips.org/Documents../definitions_of procurement and scm.pdf);

As "the acquisition by means of a public contract of works, supplies or services by one or more contracting authorities from economic operators chosen by those contracting authorities, whether or not the works, supplies or services are intended for a public purpose" (EU, Public Contracts Regulations, 2015);

"A major part of the PEM cycle by which the local administration buys works, goods, and services" (Abrahams, 2013); and or, for the purpose of this study procurement was defined as:

"A process which embodies value for money as its core principle while embracing many virtues such as transparency, competition, efficiency, accountability, fairness and economic realistic project schedules in the public PEM cycle".

This process is employed during the acquisition of public services, works and goods such as road contract works, in this context by the road implementing agencies, intended for the rehabilitation, maintenance, upgrading and or construction of public roads in the ZRS industry.

The essential objective of procurement is to ensure that all the fundamental principles governing the PEM cycle are adhered to, with a successful delivery of needed facilities to the public in order to spur eco-socio infrastructure development (Zambia Public Procurement Act, 2011).

V. Plan Procurement

A Plan Procurement is a phase which seeks to answer questions as to: what exactly should be procured? How should the procurement be done? In what quantity should we procure? What exactly should be procured and when should procurement be done? Further, Plan procurement may be defined as the progression Phase of describing the range of a project/ programme to be undertaken by governments, organisations or institutions in order to ascertain the ideal project needs to be met by procuring services from the Private Sector (Canada, 2011).

VI. Procurement Methods

Procurement methods have remained the same over the years while organizations have strived to employ different project delivery system (Baccarini, 2008). Other alternative procurement methods may be used by government agencies, multilateral development banks and public private institutions in cases where the ICB or the NCB would not be the best economic and cost effective methods (World Bank, 2011).

In Kenya, the government of the republic of Kenya through the public procurement oversight authority (PPOA) devised the procurement manual for works and came up with procurement methods, namely: open tendering; request for proposals for works and consultants; restricted tendering; direct procurement or single sourcing; low value procurements also known as request for quotations or minor works only; two staged tendering and specially permitted procurements (or PPP Contracts) (PPOA, 2009).

However, this research focused on the ZPPA's public procurement ACT of 2008, which provides a wide range of procurement methods that are available for use by all procuring entities in Zambia. Against this background, the road sector in Zambia have the privilege to access from a pool of variant procurement methods as outlined below (Zambia Public Procurement Act, 2011):

a) Open bidding

Open bidding refers to a type of procurement method in which a procuring entity publicly invites eligible bidders to tender or offer to execute an advertised work or service through a purchasing of a solicitation document or following an outlined instruction to bidders as may be outlined in the advert. Open bidding is also a benchmark for effective and efficient public procurement in that it promotes fairness, transparency, value for money and helps to reduce collusion, fraud and corruption. In addition, this method of procurement may be used to obtain eligible service providers and civil works contractors in the road sectors (WBa, 2014).

According to ZPPA Act of 2008 the public procurement regulations, 2011, open bidding may be national open bidding (ONB) or international open bidding (IOB) and requires that all procuring entities use this method of procurement for goods, works and non-consulting services. Further, the condition precedent in Zambia is that award of a contract opportunity is biased to determination of the bid with the lowest evaluated price (Zambia Public Procurement Act, 2011).

b) Open Selection and Limited Selection

The objective of open selection is to encourage the participation of the Private Sector and enable the clients to obtain the best possible shortlist worthy value for money. This type of procurement is meant for consulting services and it is usually designed as an open tender in order to encourage competition. In addition, open selection can either be open international selection (OIN) or national open selection (NOS). Despite being open to the public, open selection may prescribe specific qualification criteria to guide in the eligibility of the targeted road service providers required to participate in the bidding process. The criterion applied in the ZRS may range from affiliation to the national council for construction in respect to grade, status of a company such as citizen owned company (COC) to the domicility status of the bidding firm (NCC, 2003).

Selection tendering at national and international frontier is sought when the estimated value of the procurement surpasses the given threshold in the procurement guidelines, the consulting services could not be accessed under competitive price or from at least three suppliers/ consultants in Zambia or in the region. Consequently, procuring entities are allowed to carry out a limited selection of consulting services, where the consulting services are only available from a limited number of suppliers or on grounds of emergency This procurement method is tailored for consulting services only in which bids are obtained through specific invitation to a shortlist of bidders without advertising in any media accessed by the public (ZPPA, 2011).

The challenges to these types of procurement are similar to open bidding. Consultancy services calls for quality and cost based selection criteria. It also requires highly qualified professionals with experience. Therefore on these aspects local firms usually fall short of the required criteria and usually most jobs are taken by foreign based consulting firms. However, in certain instances a number of projects are delayed while awaiting the selection of consultants' mobilization of foreign consultants whose efficiency to mobilise from their countries is a challenge (Salleh, 2009)

c) Limited bidding and direct bidding

Limited bidding (LB) is a type of procurement which in reality is international competitive bidding except the design under this one is that eligible contractors are invited in person through writing instead of advertising in the media. On the other hand, though there is a limit in terms of number to be shortlisted it is anticipated to be broader enough to assure competitive prices. In addition. Direct bidding (DB) is another type of procurement in which a procuring entity engages a bidder directly without subjecting him/her to any form of competition. This may happen only in emergence cases otherwise this kind of procurement may lead to corruption in the selection of contractor or consultants (World Bank/IBRD, 2011).

Other Instances in which these kind of procurements may arise could be due to lack of many service providers in such works which are being sought to be done. Besides these, it can also be used when the proposed contract amount is not lucrative to attract foreign based contractors or suppliers (Asian Development Bank, 2015).

However, these types of procurement can be highly abused by procuring entities as they may become a source of corruption, collusion and fraud by avoiding open bidding, so that preferred contractor (s) can be handpicked. In its current form, the ZPPA Act shows inadequacies in ensuring that a maximum number to be shortlisted is enshrined in the act, other than stating that it should be broad enough and does not state that those to be qualified for short listing or single sourcing, should have had first passed a pre-qualification stage conducted by the procuring entity. Failure to have these clauses under the two procurement methods gives room for manipulation on the part of the contracting authority to invite any contractor of their choice. Besides, the methods lack the fundamental principles of procurement such as competition, fairness, transparency and value for money (Skitmore, 1997).

d) Simplified bidding

This is a type of procurement method used by contracting authorities in Zambia in circumstances where the threshold for procurement does not exceed K500 Million for goods, works and non-consulting services. While for consulting services, this method is applicable only when the threshold for procurement does not exceed K300 Million (Zambia Public Procurement Act, 2011).

A threshold for procurement is not in any way a fundamental principle that should govern a choice of a procurement method because project costs are determined by contracting authorities. Therefore, contracting authorities may adjust project cost in order to avoid competition and give themselves an advantage to benefit from a project by ensuring that it falls below a less competitive threshold. Because project costs with lesser thresholds does not attract competition from non-regional contractors and on the other hand having a higher project cost such as the one falling under the threshold for international competitive bidding (ICB) reduced into a threshold for simplified bidding only increases the time taken during procurement process and eventual successful project delivery (AfDB, 2014).

e) Procurement of infrastructure for private financing and award of concessions

This refers to comparable contracting, service concessions that the government may enter into with private investor to develop, operate and manage a public facility such as a road over a period of time for a return on their investment. Zambia is currently considering a number of road projects on the core road network to be carried by public private partnership (PPP) or contractor facilitated (CFI) model (RSAWP, 2017).

Procurement of infrastructure project entered into by governments use concession agreements which comes in variant forms, not limited to the following: build-lease—transfer (BLT); build-rent-transfer (BRT); build-own-operate (BOO); and build-own-operate-transfer (BOOT). These types of procurement methods are not good for developing nations like Zambia because infrastructure development is undertaken based on borrowings and the repayment period is usually very long, like it was in the case of the Suez canal which had a concession period of 99 (ninety-nine) years. This length period of time is too long for the concessionaire and the financier of a special purpose vehicle (SPV) to continue enjoying the benefits out of a constructed facility at the expense of the public of an origin country (Bunni, 2005).

Furthermore, designing, structuring and financing private and public projects poses great risks during both the pre and post construction phases. Some of the notable risks of these procurement methods which can subsequently haunt the origin country after assuming overall responsibility to care and maintain the constructed infrastructure are: increased interest rate risks which emanate from fluctuations in interest rates and depreciation of currencies against the major global currencies, especially volatile currencies are those amongst developing countries compounded by the risk of exchange rates (Gatti, 2008).

f) Community participation in procurement

This is a situation where the success of a project is anchored on the utilization of the local resources that may range from, human resource, materials and technical know-how. In addition, achievement of certain social problems like poverty may be reduced by implementation of labour intensive programmes like the Labour-based road projects. This king of projects enable the participating locals to earn salaries and be able to better their livelihood at household levels (Puddephatt, 2012).

This type of procurement is not good because it take place outside the confines of the fundamental principles of procurement as defined in this study, such as competition, transparency and fairness. A person in authority may prefer to implement a labour intensive project in his home town or place of origin based on ethnicity grounds, while disadvantaging other communities, this is so, because community participation doesn't have well defined criteria to follow but simply depends on special discretion of those in authority. That is, basically obtaining community labour, either on a voluntary or paid basis similar to a private contractor may be engaged to carry out specified works by contracting authorities (UNCDF, 2013).

VII. Methodology

The initial stage of the research reviewed the existing literature on the investigation of effects of procurement methods on project delivery from journals, books, internet and other secondary sources. Based on the obtaining findings from secondary data, questionnaire was designed.

The questionnaire was designed with three sections; section one (1) addressed demographical aspect of respondents, section two (2) addressed the procurement methods used in the construction industry while section three (3) was a guide interview with structured questions tailored to aid the researcher

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during interview of the identified key experts. The key experts were drawn from institutions which are at the centre of procurement, implementation and policy regulation in the ZRS. The target institutions to help with the research were: The RDA, MHID, NRFA, ZPPA, NCC, EIZ and the private contractors as well as consultants practicing in the ZRS.

Having had the institutions to help with the investigation or research, the appropriate sampling method which was adopted was purposive sampling method. Therefore, procurement officers, contract managers, senior engineers, site engineers, contractors and consultants among many other professionals in the ZRS who have been involved in actual contract procurement and project delivery of road works were identified, administered with questionnaires and interviewed. The overall sample size of the respondents was seventy (70).

Data collection comprised both primary and secondary data. Further, the collected data was analysed using Microsoft Excel 2013.

VIII. Findings and Results

The assessment of project works was limited to the projects that were unveiled after 2011, particularly those under the link Zambia 8000 project. During the interview of key experts, the identified desk engineers and project managers with at least ten (10) years' experience were interviewed and gave their view point concerning the performance of road projects under their charge.

The interviewee from Road Development Agency (RDA) said, "In most cases works contracts commenced before the finalisation of the designs and engagement of consultants to the projects. He further explained that this situation usually occurs due to stakeholder pressure, though mostly it is from politicians. He also stated that this situation always had retrogressive effects on successful project delivery because it is very difficult to monitor or supervise a project without designs". In addition, the interviewee disclosed that notable effects of works that commenced without designs and consultants on projects, experienced re-works and delays in completion of works. This was so because when the consultant finally got on site they found that contractors had wrongly executed certain works and therefore correction became inevitable. Consequently, project cost overruns, delays and re-works had characterized the ZRS sector. On the other hand, experts from NCC revealed that during assessment of some of the past and on-going projects they had encountered poor quality of works executed and point out that corruption should be the root cause of such substandard works noticed. They hinted that despite some of the project having had timely release of project funds, the quality of works left much to be desired. The interviewee also said incompetency of consultants and contractors had also contributed to project failure in the ZRS.

IX. Conclusion

The different types of procurement methods employed in construction of road projects has a vital role in the successful selection of a contractor to be awarded a contract opportunity and subsequent completion of the project. However, the findings of this research study concerning, the relationship between procurement method and success project delivery indicated that: A procurement method cannot be singled out to be the reason for project success or failure alone. Because every procurement method have their own procedures to follow and once they are followed the project delivery takes place with their due conditions to be met; and the conditions to be met during project delivery are the implementation of procurement factors which have been extensively analysed to establish their impact on project delivery.

X. Recommendations

Based on the findings from this study, the following recommendations are being made:

1. The Road Sector Annual Work Plan (RSAWP) should consider being framed based on the definite available funds. Presently, road sector strategic work plans are framed taking into account counterpart funding as well as revenue that the Agency have no direct control over. Further, Government should streamline the collection of revenue and decentralize collections so that Agencies like the National Road Fund Agency (NRFA) are allowed to fully collect all its revenue and operate according to its mandate: to mobilise road fund for the maintenance, rehabilitation and construction of public roads in Zambia. Such a move can certainly remove the red tape revealed in the disbursement of road user fees from the Ministry of Finance (MoF) to NRFA.
2. Works contracts should never be allowed to commence without project designs. The implementing Agency such as RDA should be supported and respected to operate independently and remove the current direct influence that comes from politicians.
3. National Council for Construction (NCC) and Zambia Public Procurement Authority (ZPPA) regulations and guidelines should be reviewed to incorporate best practices and stakeholders such

as contractors should be allowed to be part of the review exercise so that their concerns are incorporated as well. Further, adjustments of guidelines such as advance payment should not be altered only in the interest of government but any such adjustment made must be subjected to all the stakeholders before amendments are done. Presently, the RDA law on limiting advance payment to ten (10) percent and seven and half (7.5) percent to local contractors and foreign contractors, works against best practices and therefore, hinders successful negotiations regarding the same, which is an international contract administration norm.

This researcher strongly recommends that government through the Attorney General and ZPPA rescinds its decision on limitation of advance payment in order to improve the capacity of contractors.

4. Government and procurement entities should enforce a policy which should prevent personnel without formal procurement training from handling assignments related to contract administration. Further, personnel in the institutions engaged in contract administration should have a cycle deliberate policy of training their staff in procurement and contract administration training courses.
5. Government should devise deliberate policies which favour improvement of contractor's capacity such as payment high advance payment to contractors as opposed to minimisation of advance payment to contractors, Further, the current 20 percent sub-contracting policy which mandates every high tech contract awarded to major contractor to sub-contract 20 percent of the total contract sum to Zambian local contractors. The policy was meant to build capacity of the local contractors through knowledge transfer. However, it was revealed that more is expected to be done beyond the 20 percent policy pronouncement. Because, most local contractors are not acquiring high-tech knowledge transfer through the 20 percent sub-contracting policy since their capacity is too low and therefore, they are only sub-contracted to carry out very low level works such as bush clearing and grubbing. Therefore, this researcher recommends that government should consider empowering small scale contractors with equipment and financial capacities so that once sub-contracted to carry high-tech works they are able to execute them and thereby acquire knowledge.

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Effective of Seismic Load on Behavior of Rectangular Shear Wall in RC Frame structure

By Mahdi Hosseini
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Abstract- The usefulness of shear walls in the structural planning of multistory buildings has long been recognized. When walls are situated in advantageous positions in a building, they can be very efficient in resisting lateral loads originating from wind or earthquakes. Incorporation of shear wall has become inevitable in multi-storey building to resist lateral forces. In present work, twenty storey buildings have been modeled using software ETABS by dynamic analysis. All the analyses has been carried out as per the Indian Standard code books. Based on the literature of previous studies most effective positioning of shear walls has been chosen. This study is done on RC framed multistory building with RC shear walls with fixed support conditions. This paper aims to study the behaviour of reinforced concrete building by conducting dynamic analysis for most suited positions and location of Rectangular shear wall. Estimation of structural response such as; axial force, shear force, torsion, moment, storey drift is carried out. Dynamic responses under zone V earthquake as per IS 1893 (part 1): 2002 have been carried out.

Keywords: rectangular shear wall, frame structure, dynamic analysis, seismic load, structural response.

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I. Introduction

a) Seismic Load

The seismic weight of building is the sum of seismic weight of all the floors. The seismic weight of each floor is its full dead load plus appropriate amount of imposed load, the latter being that part of the imposed loads that may reasonably be expected to be attached to the structure at the time of earthquake shaking. It includes the weight of permanent and movable partitions, permanent equipment, a part of the live load, etc. While computing the seismic weight of columns and walls in any storey shall be equally distributed to the floors above and below the storey. Earthquake forces experienced by a building result from ground motions (accelerations) which are also fluctuating or dynamic in nature, in fact they reverse direction some what chaotically. The magnitude of an earthquake force depends on the magnitude of an earthquake, distance from the earthquake source(epicenter), local ground conditions that may amplify ground shaking (or dampen it), the weight (or mass) of the structure, and the type of structural system and its ability to with stand abusive cyclic loading. In theory and practice, the lateral force that a building experiences from an earthquake increases in direct proportion with the acceleration of ground motion at the building site and the mass of the building (i.e., a doubling in ground motion acceleration or building mass will double the load).This theory rests on the simplicity and validity of Newton's law of physics: F = m x a, where 'F' represents force, 'm' represents mass or weight, and 'a' represents acceleration.

b) Why are Buildings with Shear Walls Preferred in Seismic Zones?

Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

"We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls." Mark Fintel, a noted consulting engineer in USA Shear walls in high seismic regions requires special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient; both in terms of construction cost properly designed and detailed buildings with Shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote: And effectiveness in minimizing earthquake damage in structural and non-Structural elements (like glass windows and building contents).

When a building is subjected to wind or earthquake load, various types of failure must be prevented:

- Slipping off the foundation (sliding)
- Overturning and uplift (anchorage failure)

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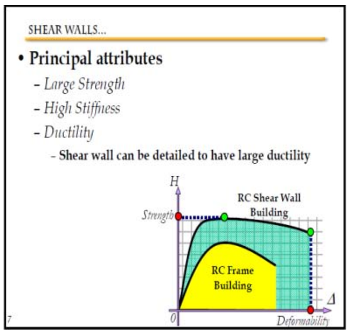
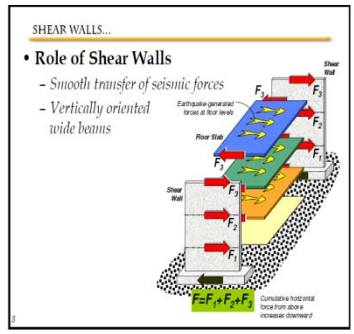
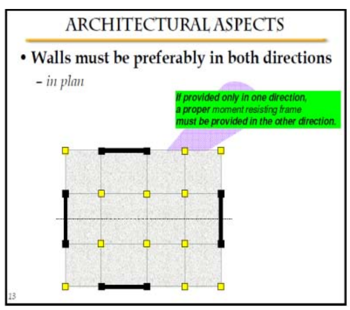
- Shear distortion (drift or racking deflection)
- Collapse (excessive racking deflection)

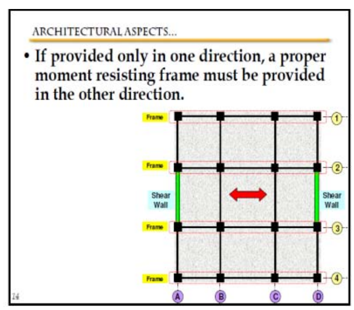
Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents.

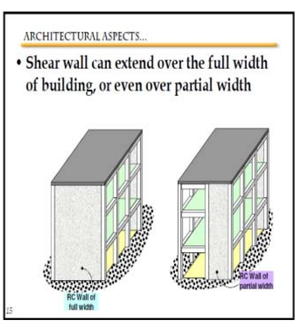
Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special Attention. Shear walls should be provided along preferably both length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong earthquake effects.

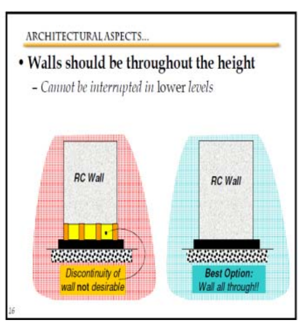


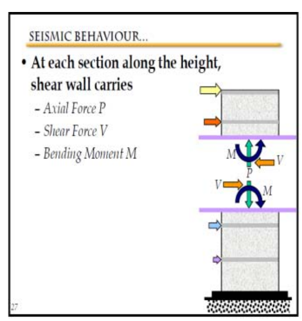


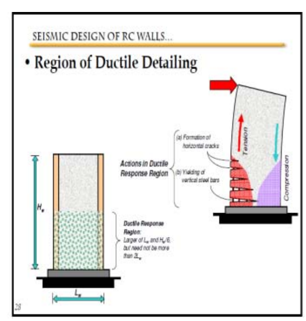


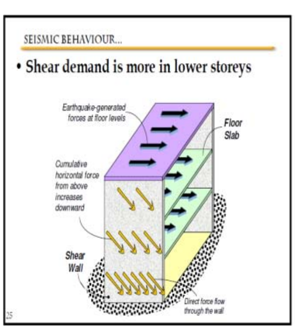


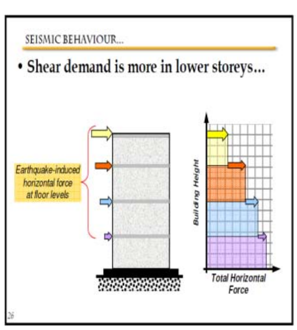












II. Methodology

Quite a few methods are available for the earthquake analysis of buildings; two of them are presented here:

1. Equivalent Static Lateral Force Method (pseudo static method).
2. Dynamic Analysis.
   i. Response spectrum method.
   ii. Time history method.

a) *Dynamic Analysis*

Dynamic analysis shall be performed to obtain the design seismic force, and its distribution in different levels along the height of the building, and in the various lateral load resisting element, for the following buildings:

Regular buildings: Those greater than 40m in height in zones IV and V, those greater than 90m in height in zone II and III.

Irregular buildings: All framed buildings higher than 12m in zones IV and V, and those greater than 40m in height in zones II and III.

The analysis of model for dynamic analysis of buildings with unusual configuration should be such that it adequately models the typ es of irregularities present in the building configuration. Buildings with plan irregularities, as defined in Table 4 of IS code: 1893-2002 cannot be modeled for dynamic analysis.

Dynamic analysis may be performed either by the Time History Method or by the Response Spectrum Method.

b) *Time History Method*

The usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics. In this method, the mathematical model of the building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure.

c) *Response Spectrum Method*

The word spectrum in engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. This method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic of steel and reinforce concrete buildings, respectively. For most buildings, inelastic response can be expected to occur during a major earthquake, implying that an inelastic analysis is more proper for design. However, in spite of the availability of nonlinear inelastic programs, they are not used in typical design practice because:

1. Their proper use requires knowledge of their inner workings and theories. design criteria and
2. Result produced are difficult to interpret and apply to traditional design criteria , and
3. The necessary computations are expensive.

Therefore, analysis in practice typically use linear elastic procedures based on the response spectrum method. The response spectrum analysis is the preferred method because it is easier to use.

III. Numerical Analyses

Structure

G+19 earthquake resistant structure with Rectangular shear wall.

a) *Problems in the Building Due to Earthquake*

Main problems that would be arising due to earthquake in the structure are story drift and deflection of the building due to its large height and also torsion and others, so if the structure is proved to be safe in all the above mentioned problems than the structure would be safe in all cases in respect earthquake.

b) *Geometrical Properties*

1. No. of stories of the Building model=20
2. Column size=500 mm x 500 mm
3. Beam size= 700 mm x 500 mm
4. Slab thickness=200mm

Loads

1. Live Load=3KN/m2
2. Wall Load=12.4KN/m
3. Floor Finishing =1KN/m2
4. Wind load

Wind Coefficients

(i) Wind Speed=50m/s
(ii) Terrain Category =2
(iii) Structure Class=B
(iv) Risk Coefficient(k1)=1
(v) Topography(k3)=1

c) *Material Properties*

Seismic Loading

(i) Seismic zone factor(Z)=0.36
(ii) Soil Type= Medium(II)
(iii) Response Reduction factor(R) =5%
(iv) Story Range=Base to 20
(v) Important factor(I)=1

Table I: The materials used in structure and their general properties are

Material Text	Unit weight KN/m3	Elastic Modulus KN/m2	Shear Modulus KN/m2	Poisson Ratio Unit less	Thermal expansion coefficient 1/C
Concrete	23.563	24855578.28	10356490.95	0.2	0.0000099
Rebar steel	76.973	199947978.8	76903068.77	0.3	0.0000117
Bar steel	76.9730	199947978.8	769030068.77	0.3	0.0000117

d) Load Combinations

Load combination is the foremost important criteria for designing any structure and more important is the distribution of those loads on to various components of the structure like beams, columns, slabs and in our case shears walls and concrete core wall too. There are many kinds of loads existing depending on the location of the where the structure is to be constructed for example in a place where wind is frequent there we have to consider the wind loads and places where rains are heavy rain loads are included and same way all the other loads such as snow loads, earthquake load and etc. are included however DEAD LOADS, LIVE LOADS AND IMPOSEDLOADS are always included. Dead loads are all common depending on the structural components and specific gravity of the structure, to get the self weight of the structural component volume or area of the component is multiplied by the specific gravity of the component. Live loads depend on the purpose we are constructing the building. Imposed loads depend on the seismic loads, dead loads and according to are 1893 part 1 percentage of those values is finally considered.

The following Load Combinations have been considered for the design.

1. (DL+ LL)
2. (DL ± EQXTP)
3. (DL ± EQYTP)
4. (DL ± EQXTN)
5. (DL ± EQYTN)
6. (DL + LL ± EQXTP)
7. (DL + LL ± EQYTP)
8. (DL + LL ± EQXTN)
9. (DL + LL ± EQYTN)
10. (DL ± WLX)
11. (DL ± WLY)
12. (DL + LL ± WLX)
13. (DL + LL ± WLY)
14. 1.5(DL+ LL)
15. 1.5(DL ± EQXTP)
16. 1.5(DL ± EQYTP)
17. 1.5(DL ± EQXTN)
18. 1.5(DL ± EQYTN)
19. 1.2(DL +LL ± EQXTP)
20. 1.2(DL +LL ± EQYTP)
21. 1.2(DL +LL ± EQXTN)
22. 1.2(DL +LL ± EQYTN)
23. 1.5(DL ± WLX)
24. 1.5(DL ± WLY)
25. 1.2(DL + LL ± WLX)
26. 1.2(DL + LL ± WLY)

DL- Dead Load
LL- Live Load
EQTP- Earth Quake load With torsion Positive
EQTN- Earth Quake load With torsion negative
WL- Wind load

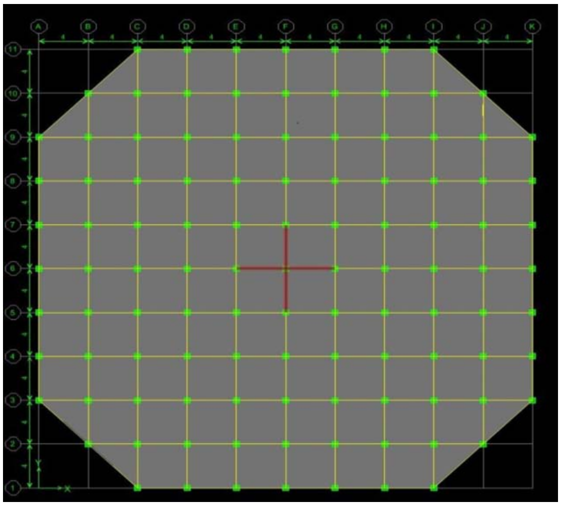


Fig. 1: Basic Plan of the Building

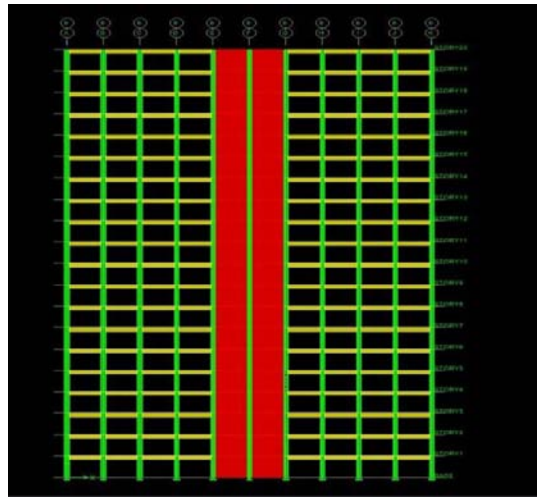


Fig. 2: Elevation of the Building

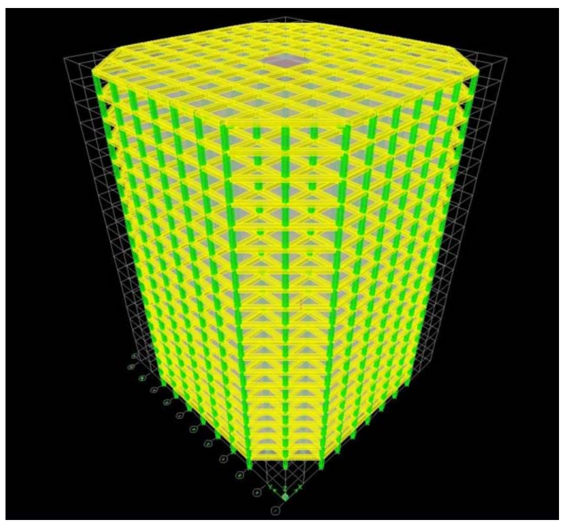
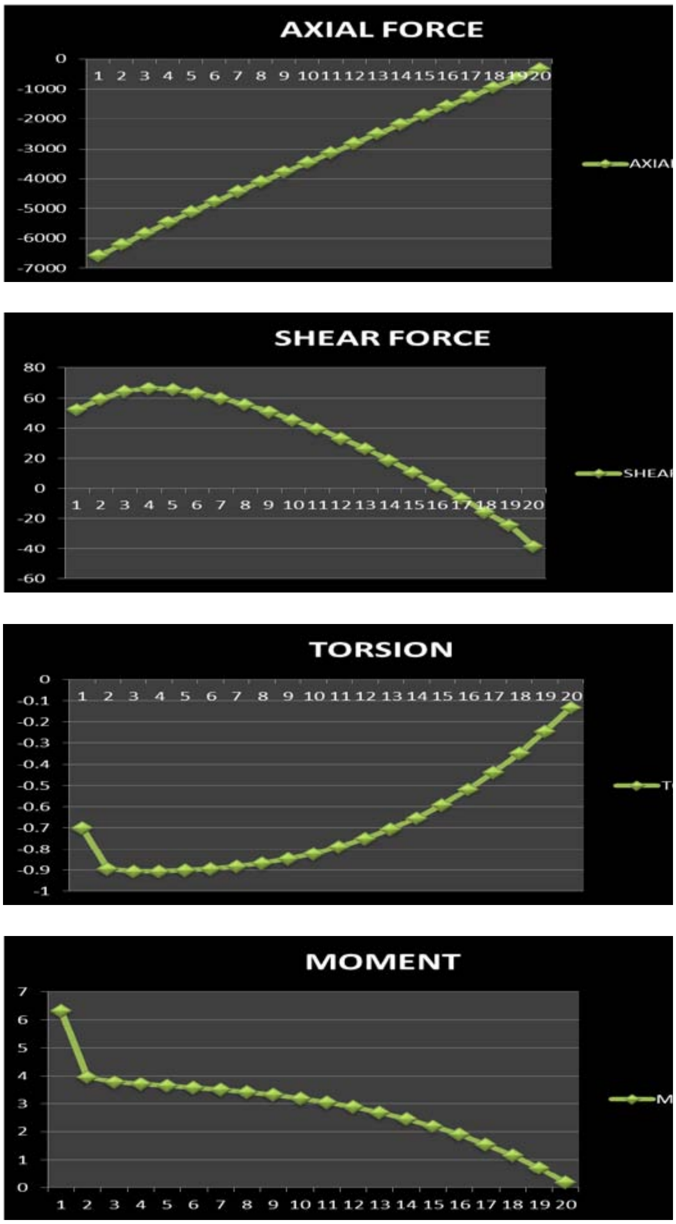


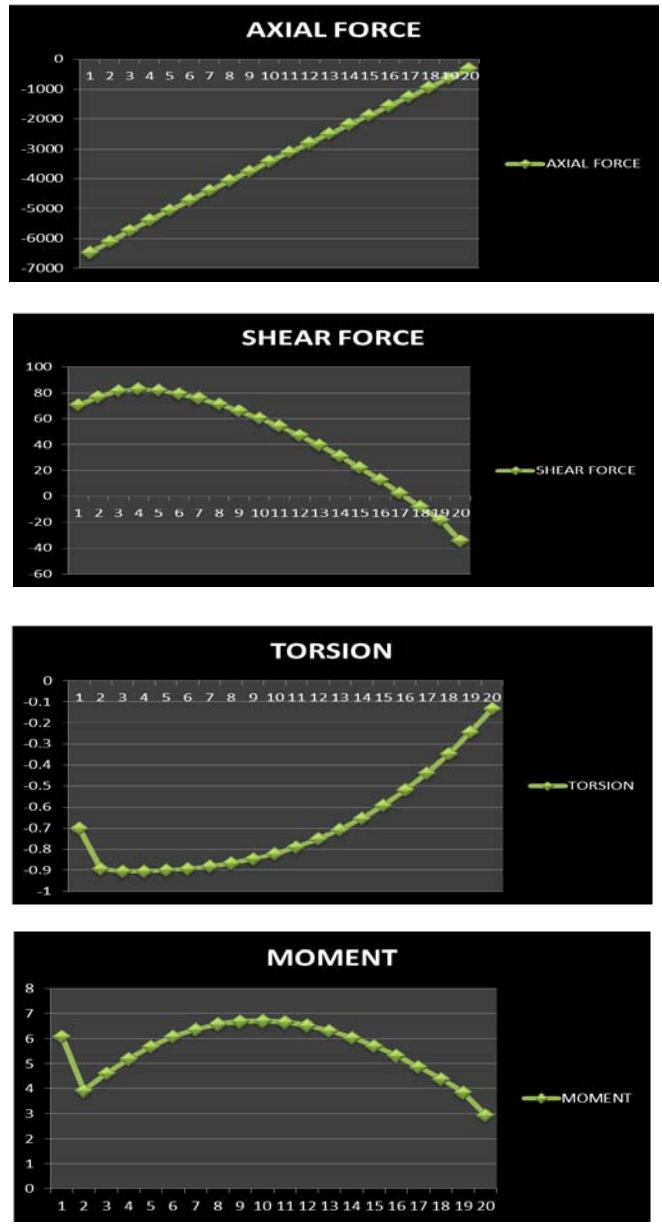
Fig. 3: 3-D Modeling

Table II: Axial force, Shear Force, Torsion and Moment for columnC3, for combination load1.2 (DL+LL+EQX)

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C3	1.2DLLLEQX	1.25	-6586.71	52.61	-0.701	6.334
STORY2	C3	1.2DLLLEQX	1.25	-6200.93	59.27	-0.894	3.966
STORY3	C3	1.2DLLLEQX	1.25	-5829.32	64.44	-0.905	3.776
STORY4	C3	1.2DLLLEQX	1.25	-5468.27	66.37	-0.904	3.712
STORY5	C3	1.2DLLLEQX	1.25	-5116.59	65.62	-0.9	3.652
STORY6	C3	1.2DLLLEQX	1.25	-4772.84	63.28	-0.893	3.584
STORY7	C3	1.2DLLLEQX	1.25	-4435.75	59.85	-0.882	3.507
STORY8	C3	1.2DLLLEQX	1.25	-4104.19	55.63	-0.867	3.419
STORY9	C3	1.2DLLLEQX	1.25	-3777.15	50.81	-0.847	3.317
STORY10	C3	1.2DLLLEQX	1.25	-3453.8	45.45	-0.822	3.197
STORY11	C3	1.2DLLLEQX	1.25	-3133.41	39.58	-0.791	3.057
STORY12	C3	1.2DLLLEQX	1.25	-2815.39	33.18	-0.752	2.891
STORY13	C3	1.2DLLLEQX	1.25	-2499.25	26.24	-0.707	2.697
STORY14	C3	1.2DLLLEQX	1.25	-2184.64	18.75	-0.653	2.47
STORY15	C3	1.2DLLLEQX	1.25	-1871.28	10.69	-0.591	2.206
STORY16	C3	1.2DLLLEQX	1.25	-1559.02	2.14	-0.519	1.9
STORY17	C3	1.2DLLLEQX	1.25	-1247.79	-6.8	-0.438	1.549
STORY18	C3	1.2DLLLEQX	1.25	-937.67	-15.87	-0.346	1.15
STORY19	C3	1.2DLLLEQX	1.25	-628.25	-24.28	-0.243	0.701
STORY20	C3	1.2DLLLEQX	1.25	-323.52	-38.57	-0.132	0.177



Graph 1: Axial force, Shear Force, Torsion and Moment for column C3



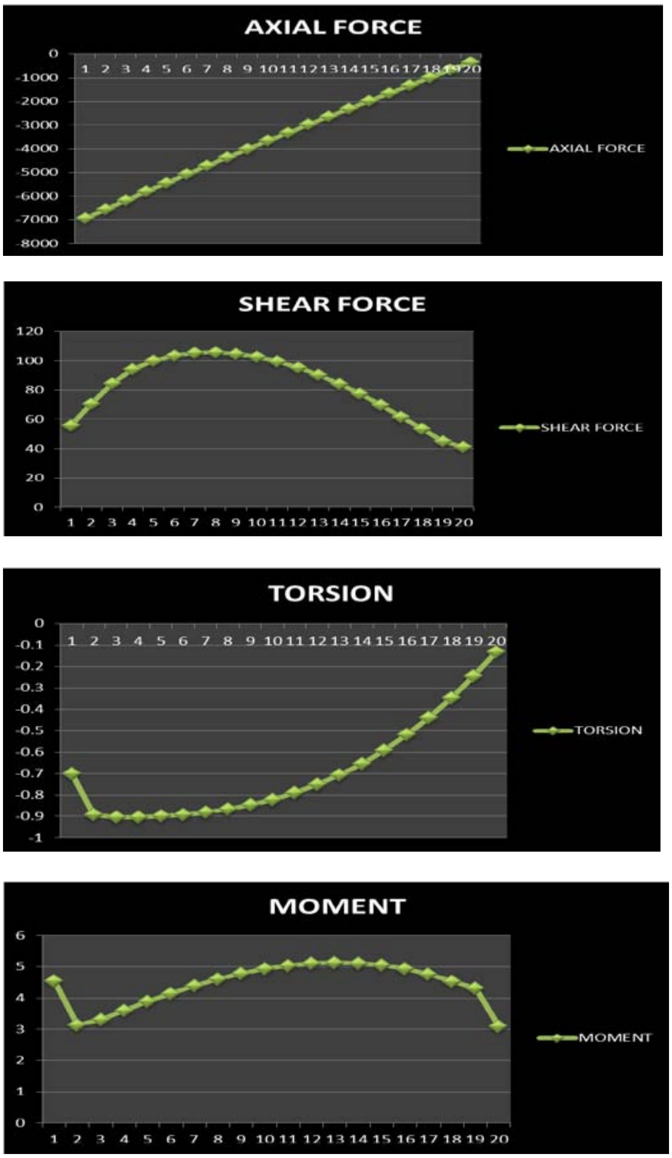
Graph 2: Axial force, Shear Force, Torsion and Moment for column C8

Table III: Axial force, Shear Force, Torsion and Moment for column C8, For combination load1.2(DL+LL+EQX)

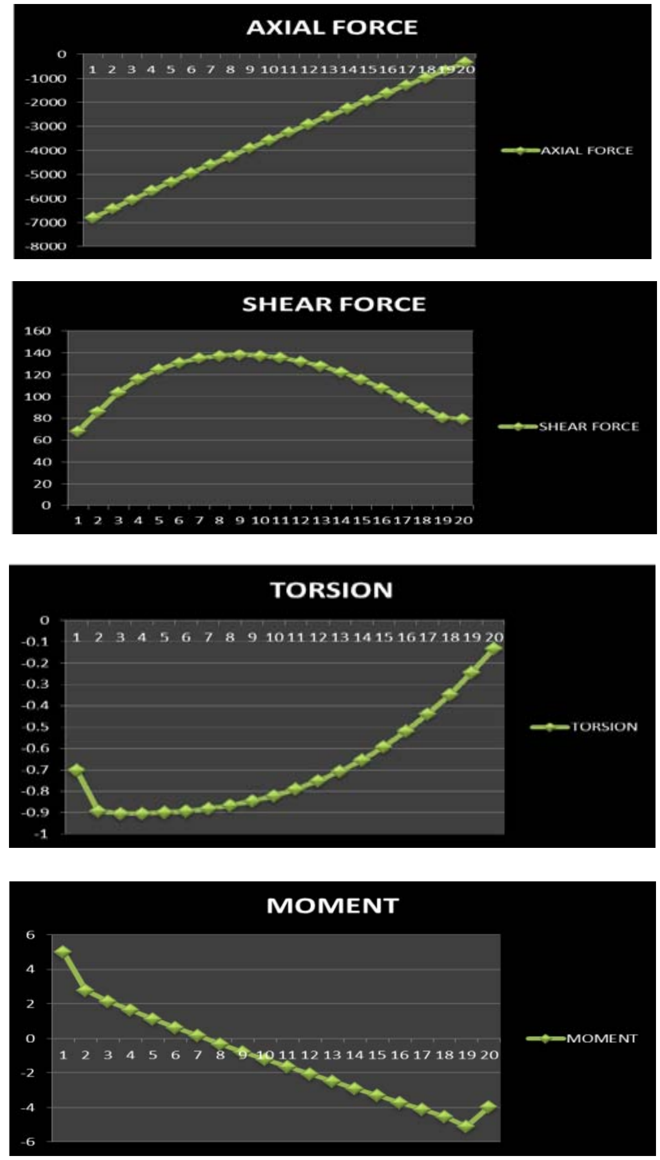
Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C8	1.2DLLLEQX	1.25	-6483.38	70.63	-0.701	6.098
STORY2	C8	1.2DLLLEQX	1.25	-6102.03	76.82	-0.894	3.919
STORY3	C8	1.2DLLLEQX	1.25	-5738.56	81.5	-0.905	4.626
STORY4	C8	1.2DLLLEQX	1.25	-5386.9	83.06	-0.904	5.194
STORY5	C8	1.2DLLLEQX	1.25	-5045.42	82.04	-0.9	5.693
STORY6	C8	1.2DLLLEQX	1.25	-4712.14	79.47	-0.893	6.085
STORY7	C8	1.2DLLLEQX	1.25	-4385.38	75.81	-0.882	6.378
STORY8	C8	1.2DLLLEQX	1.25	-4063.7	71.36	-0.867	6.577
STORY9	C8	1.2DLLLEQX	1.25	-3745.86	66.25	-0.847	6.686
STORY10	C8	1.2DLLLEQX	1.25	-3430.85	60.54	-0.822	6.711
STORY11	C8	1.2DLLLEQX	1.25	-3117.82	54.24	-0.791	6.656
STORY12	C8	1.2DLLLEQX	1.25	-2806.06	47.31	-0.752	6.525
STORY13	C8	1.2DLLLEQX	1.25	-2495.05	39.72	-0.707	6.322
STORY14	C8	1.2DLLLEQX	1.25	-2184.39	31.43	-0.653	6.052
STORY15	C8	1.2DLLLEQX	1.25	-1873.8	22.44	-0.591	5.718
STORY16	C8	1.2DLLLEQX	1.25	-1563.2	12.76	-0.519	5.326
STORY17	C8	1.2DLLLEQX	1.25	-1252.59	2.5	-0.438	4.88
STORY18	C8	1.2DLLLEQX	1.25	-942.27	-8.14	-0.346	4.393
STORY19	C8	1.2DLLLEQX	1.25	-632.04	-18.38	-0.243	3.859
STORY20	C8	1.2DLLLEQX	1.25	-326.92	-34.34	-0.132	2.942

Table IV: Axial force, Shear Force, Torsion and Moment for column C11,For combination load1.2(DL+LL+EQX)

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C11	1.2DLLLEQX	1.25	-6934.71	55.69	-0.701	4.552
STORY2	C11	1.2DLLLEQX	1.25	-6553.17	70.43	-0.894	3.132
STORY3	C11	1.2DLLLEQX	1.25	-6175.2	84.53	-0.905	3.318
STORY4	C11	1.2DLLLEQX	1.25	-5801.64	93.99	-0.904	3.609
STORY5	C11	1.2DLLLEQX	1.25	-5432.62	100.01	-0.9	3.89
STORY6	C11	1.2DLLLEQX	1.25	-5068.25	103.61	-0.893	4.153
STORY7	C11	1.2DLLLEQX	1.25	-4708.5	105.35	-0.882	4.393
STORY8	C11	1.2DLLLEQX	1.25	-4353.24	105.61	-0.867	4.606
STORY9	C11	1.2DLLLEQX	1.25	-4002.28	104.62	-0.847	4.788
STORY10	C11	1.2DLLLEQX	1.25	-3655.37	102.52	-0.822	4.935
STORY11	C11	1.2DLLLEQX	1.25	-3312.23	99.38	-0.791	5.045
STORY12	C11	1.2DLLLEQX	1.25	-2972.55	95.27	-0.752	5.114
STORY13	C11	1.2DLLLEQX	1.25	-2636.01	90.21	-0.707	5.14
STORY14	C11	1.2DLLLEQX	1.25	-2302.29	84.25	-0.653	5.12
STORY15	C11	1.2DLLLEQX	1.25	-1971.05	77.46	-0.591	5.052
STORY16	C11	1.2DLLLEQX	1.25	-1641.95	69.92	-0.519	4.934
STORY17	C11	1.2DLLLEQX	1.25	-1314.64	61.83	-0.438	4.764
STORY18	C11	1.2DLLLEQX	1.25	-988.78	53.48	-0.346	4.534
STORY19	C11	1.2DLLLEQX	1.25	-663.86	45.12	-0.243	4.324
STORY20	C11	1.2DLLLEQX	1.25	-341.55	41.25	-0.132	3.098



Graph 3: Axial force, Shear Force, Torsion and Moment for column C11



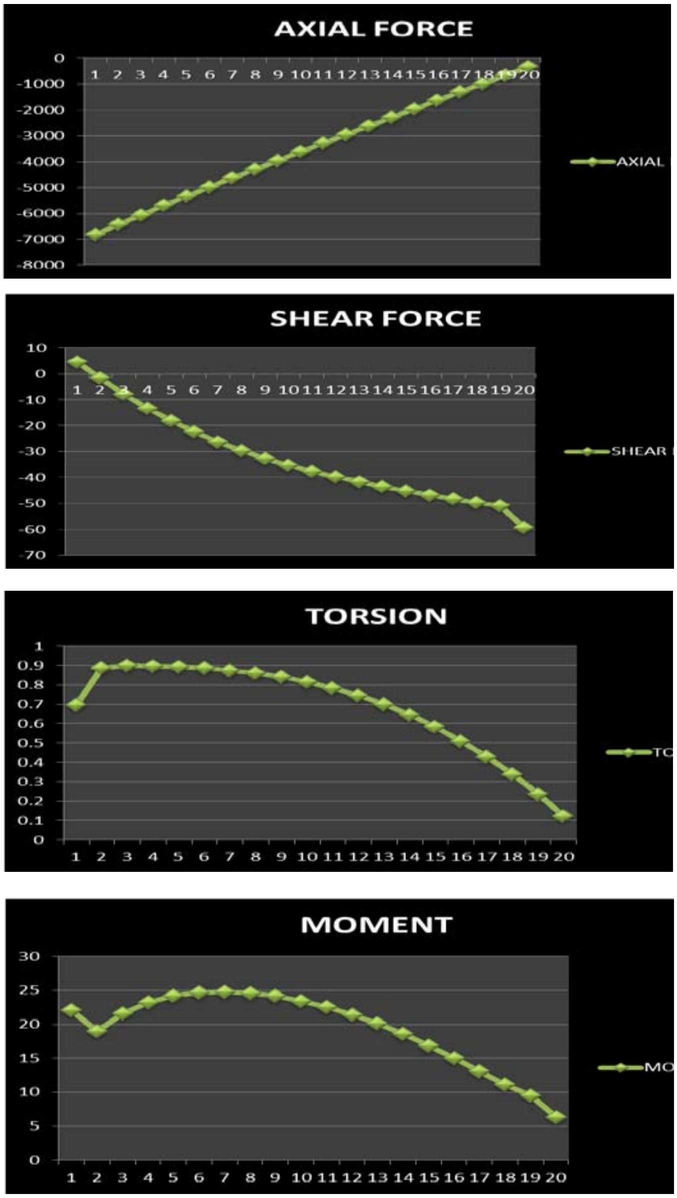
Graph 4: Axial force, Shear Force, Torsion and Moment for column C14

Table V: Axial force, Shear Force, Torsion and Moment for column C14, for combination load1.2 (DL+LL+EQX)

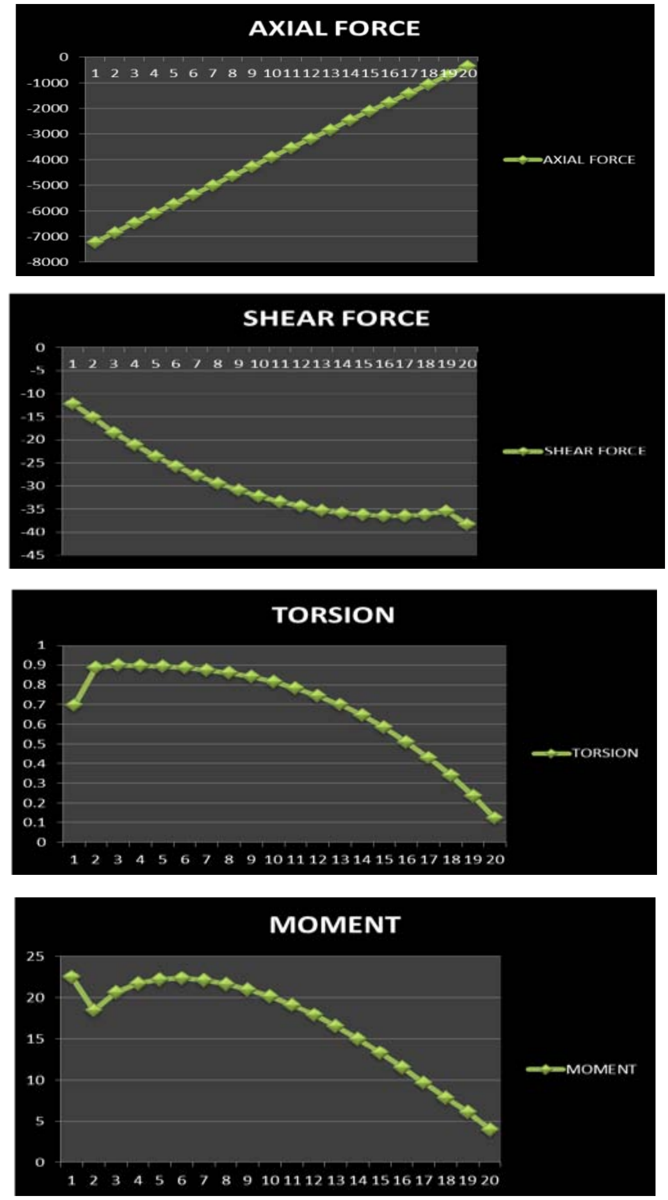
Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C14	1.2DLLLEQX	1.25	-6783.79	68.36	-0.701	5.024
STORY2	C14	1.2DLLLEQX	1.25	-6402.91	86.42	-0.894	2.786
STORY3	C14	1.2DLLLEQX	1.25	-6026.73	103.62	-0.905	2.16
STORY4	C14	1.2DLLLEQX	1.25	-5656.24	116.05	-0.904	1.645
STORY5	C14	1.2DLLLEQX	1.25	-5291.65	124.87	-0.9	1.14
STORY6	C14	1.2DLLLEQX	1.25	-4932.95	131.05	-0.893	0.644
STORY7	C14	1.2DLLLEQX	1.25	-4579.98	135.11	-0.882	0.16
STORY8	C14	1.2DLLLEQX	1.25	-4232.4	137.42	-0.867	-0.311
STORY9	C14	1.2DLLLEQX	1.25	-3889.84	138.19	-0.847	-0.769
STORY10	C14	1.2DLLLEQX	1.25	-3551.85	137.55	-0.822	-1.214
STORY11	C14	1.2DLLLEQX	1.25	-3217.98	135.59	-0.791	-1.647
STORY12	C14	1.2DLLLEQX	1.25	-2887.78	132.36	-0.752	-2.069
STORY13	C14	1.2DLLLEQX	1.25	-2560.83	127.9	-0.707	-2.484
STORY14	C14	1.2DLLLEQX	1.25	-2236.72	122.26	-0.653	-2.894
STORY15	C14	1.2DLLLEQX	1.25	-1915.07	115.51	-0.591	-3.302
STORY16	C14	1.2DLLLEQX	1.25	-1595.53	107.77	-0.519	-3.712
STORY17	C14	1.2DLLLEQX	1.25	-1277.79	99.22	-0.438	-4.128
STORY18	C14	1.2DLLLEQX	1.25	-961.52	90.17	-0.346	-4.537
STORY19	C14	1.2DLLLEQX	1.25	-646.26	80.65	-0.243	-5.113
STORY20	C14	1.2DLLLEQX	1.25	-333.95	79.49	-0.132	-3.98

Table VI: Axial force, Shear Force, Torsion and Moment for column C3, for combination load1.2 (DL+LL+EQY)

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C3	1.2DLLLEQY	1.25	-6800.3	4.62	0.699	22.041
STORY2	C3	1.2DLLLEQY	1.25	-6418.46	-1.51	0.888	18.985
STORY3	C3	1.2DLLLEQY	1.25	-6047	-7.82	0.899	21.631
STORY4	C3	1.2DLLLEQY	1.25	-5683.41	-13.23	0.898	23.242
STORY5	C3	1.2DLLLEQY	1.25	-5326.54	-18.08	0.894	24.182
STORY6	C3	1.2DLLLEQY	1.25	-4975.29	-22.37	0.887	24.671
STORY7	C3	1.2DLLLEQY	1.25	-4628.75	-26.18	0.876	24.792
STORY8	C3	1.2DLLLEQY	1.25	-4286.17	-29.55	0.861	24.613
STORY9	C3	1.2DLLLEQY	1.25	-3946.92	-32.55	0.841	24.169
STORY10	C3	1.2DLLLEQY	1.25	-3610.48	-35.22	0.816	23.484
STORY11	C3	1.2DLLLEQY	1.25	-3276.39	-37.61	0.784	22.572
STORY12	C3	1.2DLLLEQY	1.25	-2944.31	-39.76	0.746	21.443
STORY13	C3	1.2DLLLEQY	1.25	-2613.93	-41.71	0.7	20.104
STORY14	C3	1.2DLLLEQY	1.25	-2284.99	-43.49	0.646	18.571
STORY15	C3	1.2DLLLEQY	1.25	-1957.31	-45.15	0.584	16.865
STORY16	C3	1.2DLLLEQY	1.25	-1630.72	-46.71	0.512	15.021
STORY17	C3	1.2DLLLEQY	1.25	-1305.11	-48.21	0.431	13.102
STORY18	C3	1.2DLLLEQY	1.25	-980.44	-49.65	0.339	11.198
STORY19	C3	1.2DLLLEQY	1.25	-656.24	-50.72	0.236	9.531
STORY20	C3	1.2DLLLEQY	1.25	-335.79	-59.21	0.125	6.297



Graph 5: Axial force, Shear Force, Torsion and Moment for column C3



Graph 6: Axial force, Shear Force, Torsion and Moment for column C8

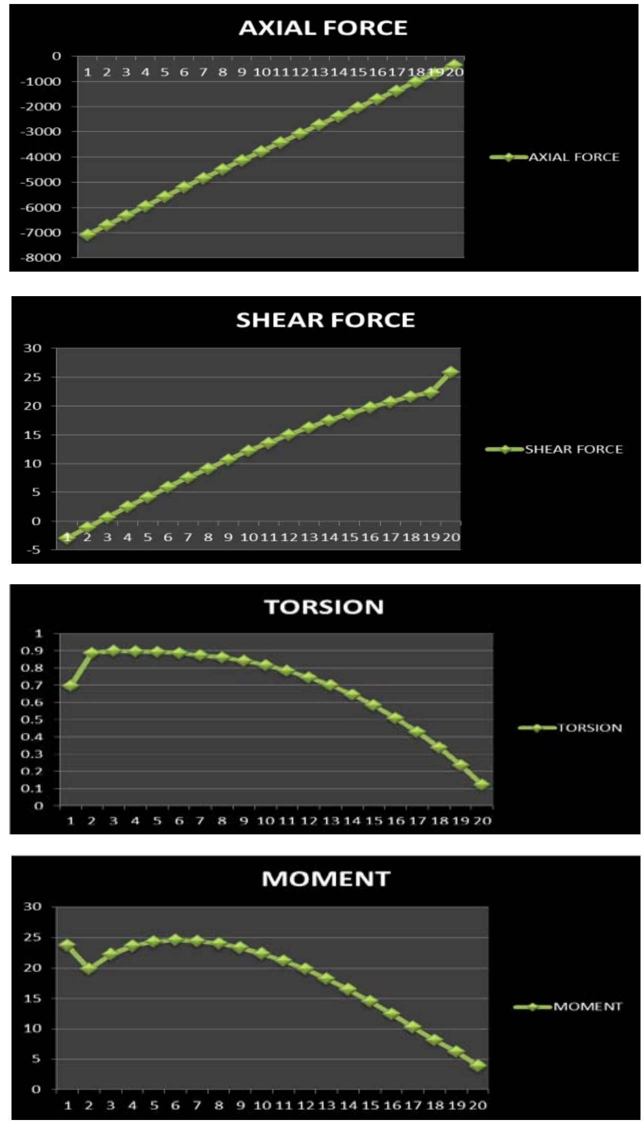
Table VII: Axial force, Shear Force, Torsion and Moment for column C8, For combination load1.2 (DL+LL+EQY)

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C8	1.2DLLLEQY	1.25	-7206.65	-12.14	0.699	22.482
STORY2	C8	1.2DLLLEQY	1.25	-6830.45	-15.16	0.888	18.521
STORY3	C8	1.2DLLLEQY	1.25	-6457.85	-18.41	0.899	20.64
STORY4	C8	1.2DLLLEQY	1.25	-6087.2	-21.12	0.898	21.731
STORY5	C8	1.2DLLLEQY	1.25	-5718.21	-23.56	0.894	22.221
STORY6	C8	1.2DLLLEQY	1.25	-5350.65	-25.72	0.887	22.322
STORY7	C8	1.2DLLLEQY	1.25	-4984.45	-27.66	0.876	22.115
STORY8	C8	1.2DLLLEQY	1.25	-4619.6	-29.38	0.861	21.665
STORY9	C8	1.2DLLLEQY	1.25	-4256.11	-30.9	0.841	21.004
STORY10	C8	1.2DLLLEQY	1.25	-3894.04	-32.25	0.816	20.152
STORY11	C8	1.2DLLLEQY	1.25	-3533.42	-33.41	0.784	19.118
STORY12	C8	1.2DLLLEQY	1.25	-3174.31	-34.4	0.746	17.909
STORY13	C8	1.2DLLLEQY	1.25	-2816.75	-35.21	0.7	16.53
STORY14	C8	1.2DLLLEQY	1.25	-2460.74	-35.84	0.646	14.991
STORY15	C8	1.2DLLLEQY	1.25	-2106.3	-36.26	0.584	13.309
STORY16	C8	1.2DLLLEQY	1.25	-1753.39	-36.47	0.512	11.516
STORY17	C8	1.2DLLLEQY	1.25	-1401.92	-36.44	0.431	9.663
STORY18	C8	1.2DLLLEQY	1.25	-1051.81	-36.13	0.339	7.851
STORY19	C8	1.2DLLLEQY	1.25	-702.51	-35.39	0.236	6.167
STORY20	C8	1.2DLLLEQY	1.25	-356.75	-38.38	0.125	3.988

Table VIII: Axial force, Shear Force, Torsion and Moment for column C11, For combination load1.2(DL+LL+EQY)

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C11	1.2DLLLEQY	1.25	-7019.18	7.49	0.699	23.415
STORY2	C11	1.2DLLLEQY	1.25	-6636.78	7.82	0.888	20.128
STORY3	C11	1.2DLLLEQY	1.25	-6257.96	8	0.899	23.039
STORY4	C11	1.2DLLLEQY	1.25	-5883.17	8.11	0.898	24.968
STORY5	C11	1.2DLLLEQY	1.25	-5512.48	8.2	0.894	26.213
STORY6	C11	1.2DLLLEQY	1.25	-5145.94	8.27	0.887	26.992
STORY7	C11	1.2DLLLEQY	1.25	-4783.48	8.33	0.876	27.383
STORY8	C11	1.2DLLLEQY	1.25	-4425	8.38	0.861	27.449
STORY9	C11	1.2DLLLEQY	1.25	-4070.31	8.41	0.841	27.224
STORY10	C11	1.2DLLLEQY	1.25	-3719.21	8.41	0.816	26.731
STORY11	C11	1.2DLLLEQY	1.25	-3371.44	8.36	0.784	25.981
STORY12	C11	1.2DLLLEQY	1.25	-3026.76	8.26	0.746	24.985
STORY13	C11	1.2DLLLEQY	1.25	-2684.87	8.09	0.7	23.751
STORY14	C11	1.2DLLLEQY	1.25	-2345.49	7.85	0.646	22.292
STORY15	C11	1.2DLLLEQY	1.25	-2008.31	7.51	0.584	20.632
STORY16	C11	1.2DLLLEQY	1.25	-1673.02	7.07	0.512	18.807
STORY17	C11	1.2DLLLEQY	1.25	-1339.31	6.52	0.431	16.878
STORY18	C11	1.2DLLLEQY	1.25	-1006.85	5.84	0.339	14.932
STORY19	C11	1.2DLLLEQY	1.25	-675.19	5.03	0.236	13.272
STORY20	C11	1.2DLLLEQY	1.25	-345.76	4.54	0.125	9.105

Graph 7: Axial force, Shear Force, Torsion and Moment for column C11



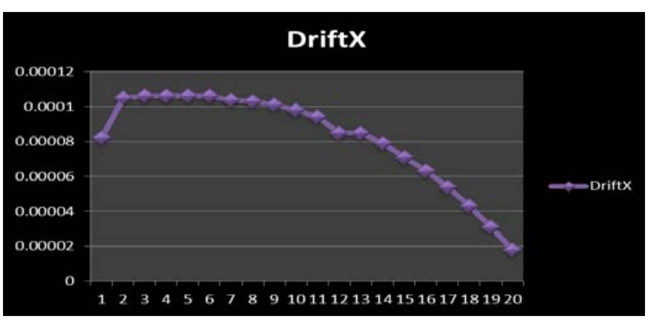
Graph 8: Axial force, Shear Force, Torsion and Moment for column C14

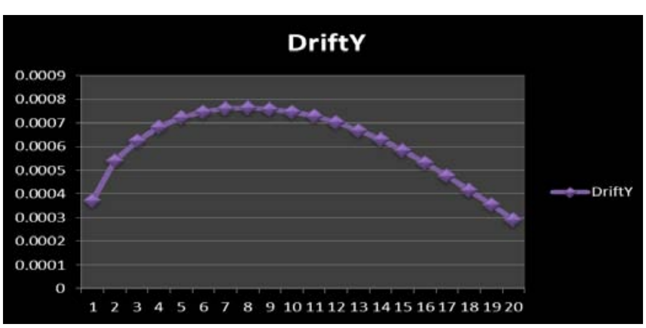
Table IX: Axial force Shear Force, Torsion and Moment for column C14,For combination load1.2 (DL+LL+EQY)

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C14	1.2DLLLEQY	1.25	-7070.16	-2.85	0.699	23.743
STORY2	C14	1.2DLLLEQY	1.25	-6687.15	-1.09	0.888	19.879
STORY3	C14	1.2DLLLEQY	1.25	-6307.79	0.76	0.899	22.248
STORY4	C14	1.2DLLLEQY	1.25	-5932.5	2.54	0.898	23.621
STORY5	C14	1.2DLLLEQY	1.25	-5561.29	4.27	0.894	24.322
STORY6	C14	1.2DLLLEQY	1.25	-5194.1	5.95	0.887	24.57
STORY7	C14	1.2DLLLEQY	1.25	-4830.76	7.59	0.876	24.446
STORY8	C14	1.2DLLLEQY	1.25	-4471.07	9.18	0.861	24.018
STORY9	C14	1.2DLLLEQY	1.25	-4114.8	10.72	0.841	23.322
STORY10	C14	1.2DLLLEQY	1.25	-3761.7	12.22	0.816	22.383
STORY11	C14	1.2DLLLEQY	1.25	-3411.5	13.65	0.784	21.215
STORY12	C14	1.2DLLLEQY	1.25	-3063.94	15.03	0.746	19.831
STORY13	C14	1.2DLLLEQY	1.25	-2718.74	16.33	0.7	18.241
STORY14	C14	1.2DLLLEQY	1.25	-2375.63	17.56	0.646	16.46
STORY15	C14	1.2DLLLEQY	1.25	-2034.36	18.71	0.584	14.513
STORY16	C14	1.2DLLLEQY	1.25	-1694.65	19.78	0.512	12.436
STORY17	C14	1.2DLLLEQY	1.25	-1356.25	20.77	0.431	10.293
STORY18	C14	1.2DLLLEQY	1.25	-1018.89	21.67	0.339	8.186
STORY19	C14	1.2DLLLEQY	1.25	-682.23	22.35	0.236	6.223
STORY20	C14	1.2DLLLEQY	1.25	-347.61	25.91	0.125	3.862

Table X: Story Drift in X and Y Direction

Story	Load	DriftX	DriftY
STORY20	DLLLLEQY	0.000018	
STORY20	DLLLLEQY		0.000292
STORY19	DLLLLEQY	0.000031	
STORY19	DLLLLEQY		0.000355
STORY18	DLLLLEQY	0.000043	
STORY18	DLLLLEQY		0.000416
STORY17	DLLLLEQY	0.000054	
STORY17	DLLLLEQY		0.000476
STORY16	DLLLLEQY	0.000063	
STORY16	DLLLLEQY		0.000532
STORY15	DLLLLEQY	0.000071	
STORY15	DLLLLEQY		0.000584
STORY14	DLLLLEQY	0.000079	
STORY14	DLLLLEQY		0.00063
STORY13	DLLLLEQY	0.000085	
STORY13	DLLLLEQY		0.000669
STORY12	DLLLLEQY	0.000085	
STORY12	DLLLLEQY		0.000702
STORY11	DLLLLEQY	0.000094	
STORY11	DLLLLEQY		0.000728
STORY10	DLLLLEQY	0.000098	
STORY10	DLLLLEQY		0.000747
STORY9	DLLLLEQY	0.000101	
STORY9	DLLLLEQY		0.000759
STORY8	DLLLLEQY	0.000103	
STORY8	DLLLLEQY		0.000763
STORY7	DLLLLEQY	0.000104	
STORY7	DLLLLEQY		0.00076
STORY6	DLLLLEQY	0.000106	
STORY6	DLLLLEQY		0.000747
STORY5	DLLLLEQY	0.000106	
STORY5	DLLLLEQY		0.000723
STORY4	DLLLLEQY	0.000106	
STORY4	DLLLLEQY		0.000684
STORY3	DLLLLEQY	0.000106	
STORY3	DLLLLEQY		0.000626
STORY2	DLLLLEQY	0.000105	
STORY2	DLLLLEQY		0.000541
STORY1	DLLLLEQY	0.000082	
STORY1	DLLLLEQY		0.000371





Graph 9: Story Drift in X& Y Direction

IV. Discussion On Results

The basic intent of design theory for earthquake resistant structures is that buildings should be able to resist minor earthquakes without damage, resist moderate earthquakes without structural damage but with some non-structural damage. To avoid collapse during a major earthquake, Members must be ductile enough to absorb and dissipate energy by post elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements. When the primary element or system yields or fails, the lateral force can be redistributed to a secondary system to prevent progressive failure.

IS 1893 (part- 1) Code recommends that detailed dynamic analysis, or pseudo static analysis should be carries out depending on the importance of the problems.

IS 1893 (part- 1) Recommends use of model analysis using response spectrum method and equivalent lateral force method for building of height less than 40m in all seismic zones as safe., but practically there may be the building which are more than 40m in height. So there exist so many problems due to the increase in height of the structure.

The following assumptions shall be made in the earthquake resistant design of structures:

Earthquake causes impulsive ground motions, which are complex and irregular in character, changing in period and amplitude each lasting for a small duration. Therefore, resonance of the type as visualized under steady-state sinusoidal excitations will not occur as it would need time to buildup such amplitudes. The structural prototype is prepared and lots of data is been collected from the prototype. All the aspects such as safety of structure in shear, moment and in story drift have been collected. So now to check whether to know whether the structure is safe with established shear walls and all construction of core wall in the center we need to compare the graphical values of structure with the shear wall and a simple rigid frame structure.

a) *Story Drift*

The tallness of a structure is relative and cannot be defined in absolute terms either in relation to height or the number of stories. The council of Tall Buildings and Urban Habitat considers building having 9 or more stories as high-rise structures. But, from a structural engineer's point of view the tall structure or multi-storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. So lateral forces due to wind or seismic loading must be considered for tall building design along with gravity forces vertical loads. Tall and slender buildings are strongly wind sensitive and wind forces are applied to the exposed surfaces of the building, whereas seismic forces are inertial (body forces), which result from the distortion of the ground and the inertial resistance of the building. These forces cause horizontal deflection is the predicted movement of a structure under lateral loads and story drift is defined as the difference in lateral deflection between two adjacent stories. Lateral deflection and drift have three effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures.

When the initial sizes of the frame members have been selected, an approximate check on the horizontal drift of the structures can be made. The drift in the non-slender rigid frame is mainly caused by racking. This racking may be considered as comprising two components: the first is due to rotation of the joints, as allowed by the double bending of the girders, while the second is caused by double bending of the columns. If the rigid frame is slender, a contribution to drift caused by the overall bending of the frame, resulting from axial deformations of the columns, may be significant. If the frame has height width ratio less than 4:1, the contribution of overall bending to the total drift at the top of the structure is usually less than 10% of that due to racking. The following method of calculation for drift allows the separate determination of the components attributable to beam bending, and overall cantilever action. Drift problem as the horizontal displacement of all tall buildings is one of the most serious issues in tall building design, relating to the dynamic characteristics of the building during earthquakes and strong winds. Drift shall be caused by the accumulated deformations of each member, such as a beam, column and shear wall. In this study analysis is done with changing structural parameters to observe the effect on the drift (lateral deflection) of the tall building due to earthquake loading.

IS 1893 Part 1 Codal Provoisions for Storey Drift Limitations

The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0, shall not exceed 0.004 times the storey height For the purposes of displacement requirements only, it is permissible to use seismic force obtained from the computed fundamental period (T) of the building without the lower bound limit on design seismic force specified in dynamic analysis. The tallness of a structure is relative and cannot be defined in absolute terms either in relation to height or the number of stories.

V. Conclusion

- It is evident from the observing result that the shear wall are making value of torsion very low.
- It is evident from the observing result that for combination loads 1.2 (DLLLEQX) & 1.2 (DLLLEQY) maximum value of moment at story one and minimum value of shear force also at story one. The Moment is maximum when the shear force is minimum or changes sign.
- The story drift for the combination load (DL+LL+EQY) in X & Y direction shown different performance and less value for story drift in all combinations at story 20.The value of story drift is very low because of adding shear walls to the building.
- Based on the analysis and discussion, shear wall are very much suitable for resisting earthquake induced lateral forces in multistoried structural systems when compared to multistoried structural systems whit out shear walls. They can be made to behave in a ductile manner by adopting proper detailing techniques.
- It is evident from the observing result that the shear wall should be near to center of mass and center of rigidity of structure.
- Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces.
- When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them, such as other shear walls, floors, foundation walls, slabs or footings.
- For the columns located away from the shear wall the Bending Moment is high and shear force is less when compared with the columns connected to the shear wall.
- Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway.
- When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.
- The vertical reinforcement that is uniformly distributed in the shear wall shall not be less than the horizontal reinforcement. This provision is particularly for squat walls (i.e. Height-to-width ratio is about 1.0). However, for walls whit height-to-width ratio less than 1.0, a major part of the shear force is resisted by the vertical reinforcement. Hence,

adequate vertical reinforcement should be provided for such walls.

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Prediction of Digital Elevation Model Height by Multivariate Adaptive Regression Splines (Mars) Interpolation Approach

By Zeena Adil Najeeb
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Abstract- The objective of this paper is to assess the applicability and performance of multivariate adoptive regression spline analysis (MARS) for prediction elevation height in digital elevation model. MARS is an adaptive, nonparametric regression approach. Three dimensional coordinates (X, Y, and Z) in Equal-Sized grid Cell observed and recognized vie Differential Global Positioning System (DGPS) at AL-Nahrain university site. Mathematical prediction models with their errors and analysis are established in this paper. As the same time the independent variables X,Y and the dependent predicted variable Z the height which be used in. The data were dividedrandomly into training and testing70% of the entire data set is utilized for training and the remaining30% for testing. MARS depends on two steps for computation logarithm forward and backward to get better performance MARS adopts Generalized Cross-Validation (GCV) with different statistical parameters of standard deviation, root mean square error and residuals.

Keywords: digital elevation model, MARS, Height prediction, DGPS.

GJRE-E Classification: *FOR Code: 090599*

PREDICTIONOFDIGITALELEVATIONMODELHEIGHTBYMULTIVARIATEADAPTIVEREGRESSIONSPLINESMARSINTERPOLATIONAPPROACH

Strictly as per the compliance and regulations of:

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Keywords: digital elevation model, mars, elevation prediction, dgps

I. Introduction

A digital elevation model (DEM) is a numerical representation of topography usually made up of equal-sized grid cells, each with an elevation value [1] DEMs have been widely used in many applications, such as urban planning, civil engineering, landscape building, and mining engineering [2].The accuracy of DEM depends on several criteria such as points distribution, type of instrument and DEM interpolation model. [1] DEMs can be obtained from contour lines, topographic maps, field surveys, photogrammetric techniques, radar interferometry, and laser altimetry [2]. In a gridding method, the corners of regular rectangles or squares are calculated from the scattered control points [3]. Interpolation in digital terrain modeling is used to determine the height value of a point by using the known height of neighboring points [4]. There are many interpolation methods that can be used to generate digital elevation models which include multiple linear regression, Nearest Neighbor, MARS, ANN, Polynomial regression etc. Multivariate Adaptive Regression Splines model is a new method for predicted the DEM height technique [5]. systematic error ,residual error will be determine in regression analysis [6] ANN interpolation is an approximate interpolator, which means that its accuracy is certainly less for known sample points. A regression analysis is used to determine if errors are attributed to any spatial attribute such as the degree of slope, aspect, or distance and direction from the set of nearest neighboring sample points [8].in MARS models data using linear predictor function and estimates unknown model parameters from this data were be used.[9]. The results demonstrate the effectiveness of the new method (MARS) model in prediction elevation height. Error and standard error was then conducted to evaluate the performance of this Interpolation models and MARS approach. Effective to measure the elevation of all points on the terrain surface. Therefore, point densification may be better executed using mathematical models. These models are particular forms of mathematical surface that deals with numerical Representation of the surface of the earth. Digital Elevation Models (DEM). Digital Height Model (DHM), Digital Ground Model (DGM), and Digital Terrain Elevation Model (DTEM) are all common terms.

II. Materials and Methodology

a) Description of the study area

The research site lies between 44° S Longitude and 33° N Latitude which districts in the middle south of Baghdad city/Iraq in Al-Nahrain university, it was cover from the total area and it is denoted by Baghdad university from west, AL-Jaderiya region from the north east site, easting(E) northing (N) and estimation elevation Height (Z) are represent surface coordinates. About 1780 points as gridding cells were be observed. these points were used in mathematical model, with an average elevation of 30 m above sea level. as illustrated in figure (1) and (2).

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Figure (1): Iraq UTM Zone

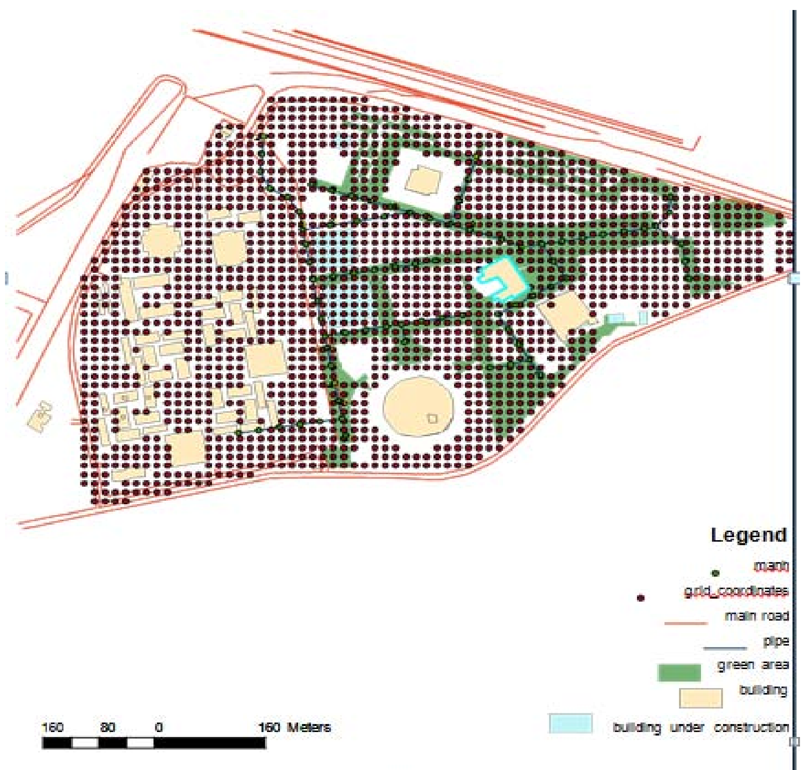

Figure (2): Selected the Study Area Showing the Gridding Cells of DEM *b) Interpolation Method*

A digital elevation model is a mathematical presentation for the surface .It employs one or more mathematical function according to some specific methods based on the set of measured data points [5].Interpolation method is used to determine the height value of a point by using the known heights of neighboring points .Also interpolation techniques can be classified according to different criteria and can be used for different purposes.

i. *Multivariate Adaptive Regression Splines (MARS)*

MARS is a powerful nonparametric model which has been successfully used in many applications of science and technology such as predicting object-oriented software maintain ability [7].MARS divides the whole space of input variable into various sub regions in different mathematical equation for each area and relates to input and output variable using spline basis functions [11].

$$[-(x-t)]_+^q = \begin{cases} (t-x)^q, & if\ x < t \\ 0, & otherwise \end{cases} \quad \cdots\cdots \quad (1)$$

$$[+(x-t)]_+^q = \begin{cases} (t-x)^q, & if\ x \geq t \\ 0, & otherwise \end{cases} \quad \cdots\cdots \quad (2)$$

where q is the power and t is knot

The final MARS model has the following form:

$$\acute{y} = \acute{f}(x) = a_0 + \sum_{M=1}^{M} a_m B_m(x) \quad (3)$$

Where

y output variable

a_0 the coefficient constant term

M the number of spline function and

$B_m$and a_m the m_{th} spline function and its coefficient respectively.

MARS uses the following two steps:

Forward Algorithm: Basis functions are introduced to define Equation (3). Which Many are added in to get better performance. However the developed MARS can have over fitting problem due to a large number of basis functions.

Backward Algorithm: to prevent over fitting, redundant basis functions are deleted from MARS adopts Generalized Cross-Validation (GCV) method to delete the redundant basis functions [12]. The GCV function is shown in Equation (4).

$$GCV = \frac{\frac{1}{N}\sum_{t=1}^{N}[y_{t-f}\ (x_t{}')]^2}{[1-\frac{c(B)}{N}]^2} \quad \cdots\cdots \quad (4)$$

WhereN the number of data and C(B) is a complexity penalty that increases with the number of basis function (BF) in the model and it is defined as:

$$C(B) = (B+1) + dB \quad (5)$$

Whered is a penalty for each BF included into the model and B the number of basis functions in Equation (3) [13].

A sensitivity analysis has been done to extract the cause and effect relationship between the inputs and outputs of the MARS model. The basic idea is that each input of the model is offset slightly and the corresponding change in the output is reported. The procedure has been taken from the work of Pijush and Kothari [14]. Accordingly the sensitivity (S) of each input parameter has been calculated by the following formula:

$$S(\%) = \frac{1}{N}\sum_{j=1}^{N}\left(\frac{\%\ change\ in\ output}{\%\ change\ in\ input}\right)_j \times 100 \quad (6)$$

Additionaly Comparison made in terms root mean squareerror (RMSE) and mean absolute error (MAE). The values of RMSE and MAE have been determined by using the following relation below:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Q_{ai} - Q_{pi})^2}{n}} \quad (7)$$

$$MAE = \frac{\sum_{i=1}^{n}|Q_{ai} - Q_{pi}|}{n} \quad (8)$$

Where Qai and Qpi are the actual and predicted Q values, respectively, and n the number of data.

ii. *Data Mining the Mars Mathmatical Model*

Data mining (DM) tools in Statistica version 12was used to predicted height of observed points by making regression logarithm using flexible model building strategy.

In this study software was used in developing mutative adoptive regression spline mathematical model to predict height Continuous dependent variables (Elevations) and continuous independent variables (Eastings and Northings) for all ground control points were used in the MARS. The data were divided in two sets with about 70% of them used for training and the rest for testing the results. The training data points were used to train the network and compute the weights of the inputs [10].The cross-validation method computes the error in a test set at the same time that the model is being trained. The test data points were used to measure the performance of the selected MARS model.

In order to develop the best possible model, all patterns that are contained in the data need to be included in the training set. Similarly, since the test set is used to determine when to stop training, it needs to be representative of all data, and thus should contain all of the patterns that are present in the available data.

Data mining in Statistica was used since it uses a large-data prediction for variables with MARS model specification having a minimum number of basis functions and showing good result in the prediction.

III. Results for Mars Model and Discussion

Although MARS is widely applied in different fields, it is not widely used in surveying applications.

Thus, we investigated the performance of the MARS digital elevation model interpolation technique to predict the heights from the digital elevation model. DGPS survey data revealed the accuracy of prediction on different points. These results were compared with the testing and training summarization of the GCV using the statistical parameters of standard deviation, root mean square error, and residuals on the both testing and training points, which are shown in Table 1.

Table 1: Summarization Model

Model specifications 30% points	Value	Model specifications 70% points	Value
Independents	2	Independents	2
Dependents	1	Dependents	1
Number of Terms	6	Number of Terms	6
Number of Basis function	5	Number of Basis function	5
GCV	0.114645	GCV	0.183028

Regression statistics were used to compare the validation method, which indicates the best performance with respect to the mean and to the standard deviation as illustrated in Tables 2 and 3.

Table 2: Regression Testing Points 30% Results

Regression statistics	Regression statistics Testing points 30%
	Elevation
Mean (observed)	30.04858
Standard deviation (observed)	0.37972
Mean (predicted)	30.04858
Standard deviation (predicted)	0.17059
Mean (residual)	0.00000
Standard deviation (residual)	0.33925
R-square	0.20182
R-square adjusted	0.19492

Table 3: Regression Training Points 70% Results

Regression statistics	Regression statistics Training points 70%
	Elevation
Mean (observed)	30.60330
Standard deviation (observed)	2.08747
Mean (predicted)	30.60330
Standard deviation (predicted)	2.04379
Mean (residual)	0.00000
Standard deviation (residual)	0.42478
R-square	0.95859
R-square adjusted	0.95842

A two-dimensional scatter plot of the predictions, observations, and residuals for each elevation are illustrated in Figures 3 and 4. The scatter plots refer to the optimum results from the random data in which testing and training points were selected. The final strategy for the value used in the GCV are goodness of fit, RMSE, and residuals, which leads to the optimum MARS model S obtained from the testing and training

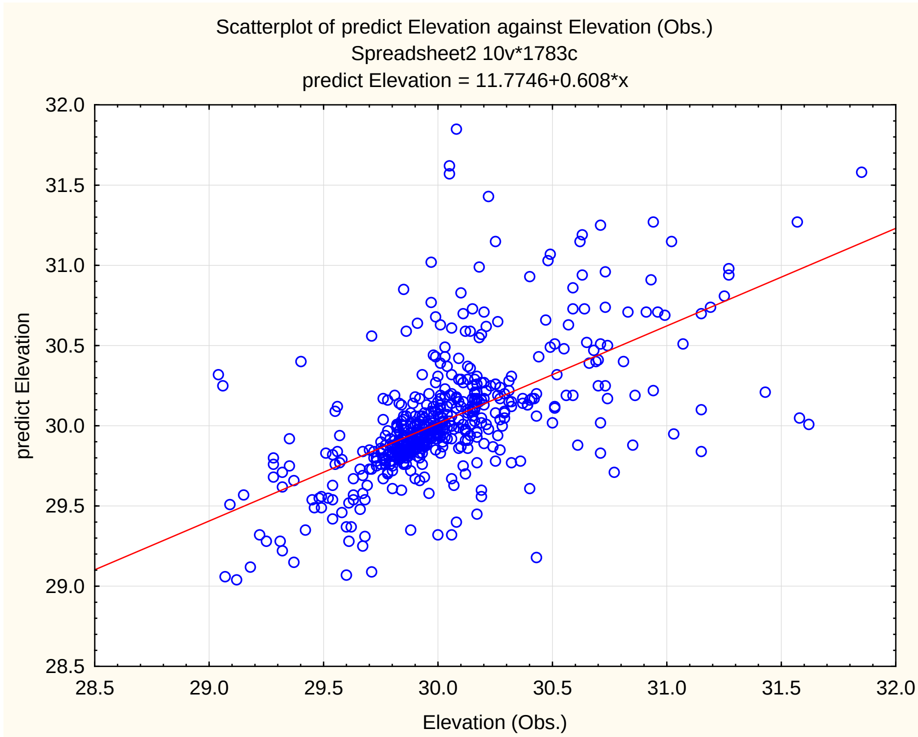

Figure 3: Two-dimensional scatter plot of the predicted elevations against the observed elevations from the testing points.

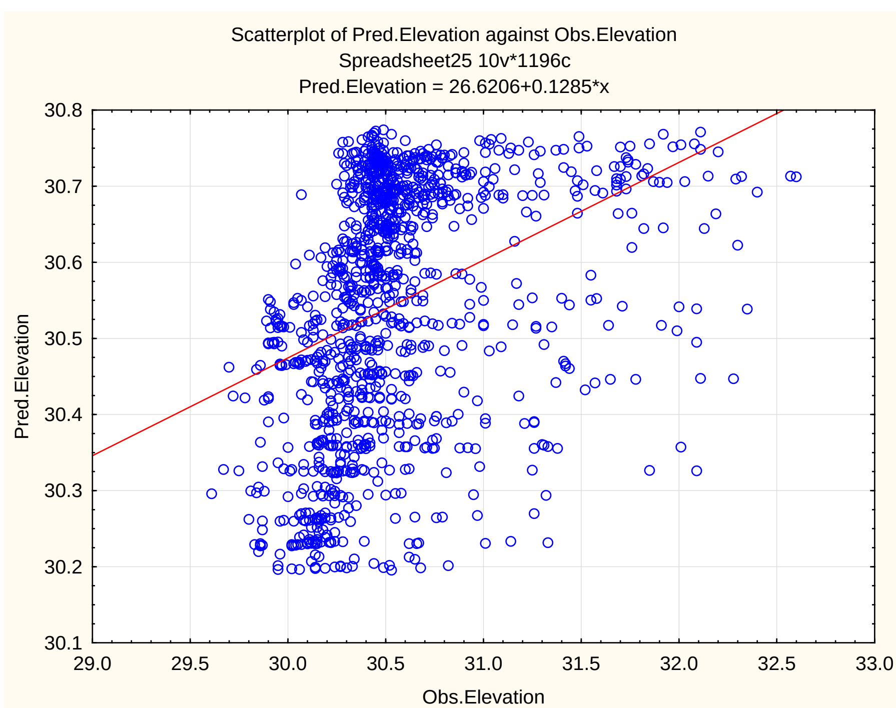

Figure 4: Scatter plot of the predicted elevations against the observed elevation derived from the training points.

IV. Conclusions

This work is part of series of interpolation DEM methods coming soon, the author wishes to express his appreciation to the Al_Nahrain University Survey Team for providing us with the data. It successfully adopted the MARS model to predict elevations showing high accuracy using a flat terrain digital elevation model. In addition, it shows the efficiency of computing residuals from a large set of data. The MARS model resulted in acceptable performance using the developed equations for determining minimum and maximum elevation. This study shows that MARS can be used as a robust tool for solving different problems in Geomatics engineering.

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The Imperatives of Effective Documentation in Contract Administration and Management in Nigeria

By Dr. Uchenna Obiekwe Ajator

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THEIMPERATIVESOFEFFECTIVEDOCUMENTATIONINCONTRACTADMINISTRATIONANDMANAGEMENTINNIGERIA

Strictly as per the compliance and regulations of:

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I. Introduction

Construction projects development depend on effective documentation for success because they require complex interactions of multiple stakeholders and participants. Effective documentation of projects requires synthesis and integration of contributions from all parties involved in ownership, use, design, estimation, construction, operation, management, oversight and maintenance, who must work together in structured, organized and collaborative manner in the project documentation chain (Ajator, 2012, 2012a; Ajator etal,2011) to ensure success.

The conceptual questions in effective documentation for successful contract administration and management include among others:

- What level of quality is exercised in structuring project briefs/ requirements by the client, his agent and user?
- What level of quality is exercised in producing geotechnical, architectural, civil, structural, mechanical/electrical designs transformed into physical structures by contractors?
- What level of quality is applied in documenting for contractors and consultants procurement?
- How accurate and comprehensive are the project cost estimate/bills of quantities?
- Does planning for execution provide specific, accurate, real-time details on scope, work breakdown structure (WBS), schedule, networks, milestones, budgets, cash flow analysis, labour, material and equipment requirements and safety/risk control standards?
- Are there control/reporting system that provide for monitoring and feedback at all stages and which enables comparison of schedules, budgets and standard performance with actual achievements and project goals?
- To what extent are these imperative documentation issues elaborately covered in the four documentation phase requirements of pretender documentation, Tender documentation, contract administration and monitoring/ evaluation documentation and interfaced to ensure ultimate project success?

The objective of this research is thus to attempt to expose some of the key techniques and knowhow of these imperative documentation paradigms in contract management.

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Table 2.1: Importance Index (II) of Some Project Documentation Variables

	Documentation Quality Variable (DQVS)	Weighed Rating		
		No. of Resp W	Score % S	Imp Index WXS
1	Project Brief/ Requirements Documentation	32	70	22
2	Project Design	33	80	26
3	Cost Engineering/BOQ Preparation	36	89	32
4	Construction Plan Documentation	35	75	26
5	Implementation Sequence Documentation	33	60	20
6	Budgeting/Cashflow Documentation	31	65	20
7	Earned Value Management Documentation	25	61	15
8	Labour/Plant/Equipment Statements	33	60	20
9	Control/ Report System Documentation	25	56	14
10	Project Inspections/Site Meetings/ Minutes Documentation	26	58	15
11	Valuation/Certificates Documentation	30	62	19
12	Change Orders (variations)/ Other Instructions Documentation	29	78	23
13	Price Fluctuation Documentation	26	50	13
14	Day Works Claims Documentation	18	50	9
15	Accidents/Force Majure/Weather Change/Dispute Documentation	16	45	7

Source: Field survey 2009/2010, in Ajator (2012)

II. Literature Review

Most projects require the use of basic contract documents. These include (IBRD,1999,Langdon, 2007); articles of agreement, conditions of contract with all necessary deletions/ amendments if standard form is used, drawing/or specifications of work to be done. Cost estimates/ priced bills of quantities including post-tender negotiation documentation, and contract programme/ progress charts. Other basic documentations required in projects include pre-tender documentations, early warning charts, quality performance charts, minutes of site meetings, project instructions, valuations/ certifications, cash flow and earned value management among others. Ajator (2012) recorded the importance index of some project documentation variables (see Table 2.1) in which professionals ascribed high percentage ratings of 32,26,26 and 23 to BOQ preparation, project design, construction plan and change orders (variation) documentations respectively.

When these variables are efficiently documented, they provide relevant databases for resolution of disputes at project delivery.

Other researches (Ajator, 2007, 2000a, 2000b; Project Documentation Certification Taskforce,1997; Galo, etal 2002; Tilly, etal 2000, 2002; Love etal, 2000,1996) have identified declining quality of these documentations and disregard of due processes and inefficiencies which have resulted in increased project cost, time, risk, delay and disputes. Tilley, et al (2002), Gallo, etal (2002) and Ajator (2012) specifically identified issues associated with documentation failings and its manifestations, some of which are consequential on others and some involving more than one stakeholders.

Client-Related Causes of Documentation Failings Include:

- Unclear, vague and uncoordinated brief
- Inadequate knowledge of the implications of their expectations, demands and directions, inadequate recognition of life cycle implications at briefing and design phases.
- Penchant for low initial capital cost.
- Lowest price mentality in engagement of designers/professionals.
- Unrealistic expectations about time and cost impacts/constraints.
- Defensive approach to Variations and claims for increased cost and time.
- Failure to appoint overall project manager or commission design team at appropriate stages of a project.

a) *Designer-Related Causes*

These Include:

- Inexperienced design personnel, inappropriate design and design checking, conservative design, build ability problems.
- Legally/ statutorily non-complaint design, quick-fix/rushed design.

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- "Cut and paste" design syndrome and consequent ambiguities due to lack of integration, and quest to reduce design time to agreed fee.
- Shedding of design cost risks rather than providing quality documentation.
- Inadequate checking of details and insufficient reviews with relevant parties and inadequate coordination between geotechnical/structural engineering, architectural, electrical and mechanical design disciplines, result in "design-by-crisis" approach leaving design issues to be sorted out in the construction process and compounding constructability issues.
- Design documentation issued with known deficiencies. Professional impunity and disregard for ethics.
- Design draft men expertise displaced by fledging CAD-operators' service, thus impacting document-tation quality in the short run.
- Reluctance to allocate experienced staff to projects because of inadequate fees agreed with clients, result in optimum project solution not provided and job not done right first time, thus increasing disputes, time and cost levels.

b) Estimator-Related/Other Documentation Failings

Cost estimate documentation failings largely arise from inadequate project design/definition, use of quacks and inexperienced estimators and non professional quantity surveyors/cost engineers.

Accuracy of estimate must base on bottom-up approach/WBS and activity cost coding/cost accounts. Relevant executory personnel must be used to analyze cost at the lowest possible work units or finest detail with minimal provisional items and estimator bias. Ineffective estimate documentation result from inadequate cost data bases, poor understanding and experience of the terrain, the technologies, various currencies/conversion rates, the duties, Ports' charges, transport systems (both local and international) available and costs of finance and funding system. Apart from possible inaccuracy of analyzed benchmark cost and factoring errors, there is often problem of improper planning and non-inclusion of all work items for which cost/prices must be allocated (Ajator,1989,1999, Aliyu, 2006).

In high "import-factor" infrastructure projects, other important cost consideration must include cost of shipping, stacking in the factory (demurrage charges, by manufacturers), marine insurance, clearing costs at ports, duties, insurance, warehousing, local transportation etc. These real costs where not documented can cause disputes and project failure.

c) Tender/Other Documentation Failings

Tendering procedures involving multiple notices to tenderers and question/answer steps erode document accuracy due to short time available for amendments. Bidders withhold important questions that may reveal their competitive edge especially in complicated warped award processes and short tender times.

d) Contractor-Related Documentation Issues

Contractors strive to redistribute risk to other sake holders, engage low cost and low skilled subcontractor, choose to withhold useful tender information (RFIS). Make spurious unsubstantiated claims' submissions to recover losses arising from initial low bids, inflate invoices, insurance and bond claims to cover perceived risks and difficulties in maintaining skill levels. The general causes impeding effective documentation involving all parties include; inadequate time for project planning, relevant parties not involved in project planning (eg project monitoring consultants) early enough, especially at concept and decision times; slow responses by most clients and their agents to questions/ queries from bidders at tender, and contractors at construction stage, worsen rather than improve documentation quality, and adversarial attitude embedded in the procurement culture.

e) Relevance of Effective Documentation in Procurement

The vehicle for achieving national development is efficient procurement. But this must obtain through monitoring which inturn depends on Effective Documentation.

Procurement is viewed by Ajator and Agusiobu (2007) and Eze (2009) as the acquisition of goods, works and/or services at the best possible total cost of ownership, in the right quantity and quality at the right time, in the right place for the direct benefit or use of Government, corporation/organization or individuals. The key to the achievement of effective procurement is monitoring and evaluation. To monitor, there must be well documented plan of activities, standards and cost baselines against which the actual is compared or benchmarked. Hence to monitor is to keep under observation and check for possible deviations from plans, standards and cost levels. So effective documentation which provides these plans, standards and baselines; becomes of paramount importance.

The importance of documentation can be seen from project procurement monitoring steps which include among others checking the:

- Existence of need-driven procurement plan (project preparation/ Formulation documentation).
- Documented projects to ensure that only appropriated projects are implemented.
- Adequacy of prepared document.
- Advertisement of project.

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- Transparency of prequalification (visible from the documents) and
- Transparency of bids and bid evaluation (both Technical/Financial bids)
- Transparency of awards of contracts (to lowest competitive bid).

Effective project documentation must therefore provide requirements that cover four main phases:

- Documentation for Project Preparation/Formulation (Pre-tender documentation)
- Documentation for Project Procurement (Tender documentation)
- Documentation at Project Implementation (Contract Admin documentation)
- Documentation for Contract Oversight/Audit (Monitoring/Evaluation documentation).

f) Documentation for Project Preparation/Formulation

This must cover the key problems/needs of the project, expected benefits, alternatives/options, alignment of the projects with Federal Government of Nigeria (FGN) Sectoral projects' preferences, competitiveness of project costs, their feasibility, financial/economic analysis, environmental impact, and detailed project designs, future operation/ maintenance requirements, implementation plans and proper packaging (Ajator,2012a).

Efficient documentation of these subjects provides clear guidelines, standards and cost targets to facilitate examining their adequacy to achieve national goal and objectives.

The content of these documents constitute approved guidelines/ standards for monitoring the activities and projects at execution stage. Failure of documentation at this stage renders abortive monitoring and evaluation at execution stage.

g) Documentation for Project Procurement

For Project procurement, documentation must encompass; preparation of tender documents/ requirements; contract drawings, contract conditions and bills etc. notification/advertising methods and medium. Pre-qualification exercise, setting appropriate bid time, special bid process (if any) in line with FGN's procurement guidelines which harps on open competitive and transparent bid process, bid evaluation/ tender report and award template. Appropriate tender board size and structure. Objective negotiation and approval of selection criteria. Mobilization, Surety or bonds requirements. And compliance assessment template. All in line with FGN extant procurement guidelines. These documentations will facilitate checking or monitoring transparency of procurement process as necessary building block for cost-effective project implementation.

h) Documentation at Project Implementation

Here the appropriated funds for the project(s) and planned tranche releases from contract conditions are documented. Periods of site visits by project consultants/supervisors, residency plans, prescriptive specifications and performance specifications and agencies'/ statutory organizations' obligations to the contract as documented in the contract conditions are highlighted. Project Evaluation and Control documents widely dominate the documentation at project implementation stage (Ajator & Onyechi, 2011). They encompass documentation of interim valuations, paid and unpaid certificates, valuation of variations, claims, fluctuations, records of unanticipated site/ work conditions, day works, projects' instructions confirmed and unconfirmed, weather conditions, records of notices, wavers, omissions, accidents, minutes of site meetings, catastrophic event, riot, war etc.

They equally include project goal, plan, cost estimate, network schedule, budget, control and management objectives, implementation programmes (PPC), Cash flow documentations and earned value analysis and management.

Evaluation and Control documents seek to facilitate regular monitoring of project achievement by comparing actual performance and progress against planned performance and progress. So that when deviations from planned progress occur, corrective actions/ re-plan are implemented. The intent of this documentation (especially earned value management) is for early discovery of current/future departure from planned course, so that adjustments can be made in good time.

Essentials of Effective Evaluation/ Control System (Austen & Neal, 1984, Ajator, etal 2015).

- It should draw immediate attention to significant deviations from what is planned.
- It should enable true and meaningful comparison to be possible.
- The information should indicate necessary corrective action and by whom.
- It should be expressed in simple form, so that it is readily understood by those who have to make use of it.
- Key areas of control must be chosen with care, so that the results of control are worth the time and effort expended.
- Monitoring and control baselines, cost performance standard or critical condition for success must be set and periodically updated applying appropriate cost/price indices (Ajator,2012a;Ajator, etal 2015; Onyechi,1991).

i) Extended Benefits of Effective Documentation

Part of the extended benefits of effective documentation which we must reflect as we produce documentation for projects is that it must provide seat for achievement of good public procurement which manifest in:

- ➢ Prudent use of resources to achieve development priority at record time.
- ➢ Projects executed as planned to the benefit of people.
- ➢ Promotion of professionalism. Efficiency, innovation, optimal cost and value for money.
- ➢ Reduce contract/project disputes, arbitration and/or litigation.
- ➢ Elimination of tendency for project abandonment and debt burden on the part of contractors, consultants and Governments.
- ➢ Elimination of rent-seeking, eye-service, laziness and influence peddling.
- ➢ Guarantee of investor' confidence, private/public partnership and co-operation in capital delivery.
- ➢ Provide ample opportunities for competition, transparency and public confidence in governance and rebranding of national image.

j) For States and Local Governments

Effective documentation where it drives effective procurements:

- ➢ Ensures that development projects are planned (involving community Development Associations (CDAS) and adequately provided for in the budget.
- ➢ Frees available resources to accommodate many projects.
- ➢ Promotes growth of use of local materials, local contractor/ industries and engender respect for hard work.
- ➢ Support the winning of public contracts by only honest professionals and competent contractors.
- ➢ Promote fast and even spread of social amenities to towns and villages.
- ➢ Reduce the tendency for delayed payment/ performance on the part of Government/ contractor or both.
- ➢ Guarantee service delivery, accountability and reward for excellence.
- ➢ Promote fast and even development, even at the grass root as ripple- effects of effective documentation.

III. Imperatives of Effective Documentation

Evident from the foregoing is that:

- Success of physical and social infrastructure development contract must obtain through control.
- But control cannot be achieved without project monitoring.
- And monitoring must be achieved through proper project documentation including components cost definitions, programming and budgeting.
- For efficient and effective project documentation to emerge, Project partnering spirit (openness) must be exhibited by all project participants/ stakeholders (Ajator, etal 2008).
- Contract cash flow documentations must be accurate, both professional quantity surveyors' /contractors' cash flows.
- Consultants and contractors must be less insular and exercise/disclose accurate valuations; budgeted cost of work performed (BCWP), and Budgeted cost of work scheduled (BCWS).
- Authentic verifiable cost expenditure profile which culminate in actual cost of work performed (ACWP) must be presented.
- All these are necessary for the location of cost variance (CV) and schedule variance (SV) and projection of future performance indices (cost performance index (CPI) and schedule performance index (SPI).
- These are essential metrics for measuring current and future performances of the administered projects
- There must be proper contract oversight/audit documentation.

Effective Documentation will Facilitate the Resolution of the Usual Contract Dispute Variables:

- ❖ Whether or not work is to the specified standards.
- ❖ Whether work is or not a variation
- ❖ Whether method for pricing of variations is followed
- ❖ Whether Architect instructions are adequate or late or whether contractor has abided by the provisions of giving prompt notices.
- ❖ Whether a valuation or financial certificate is adequate or late
- ❖ Whether completion is likely to be delayed
- ❖ Whether regular progress is being disrupted
- ❖ Accurate or inaccurate ascertainment of loss and/or expense
- ❖ Changes in ground condition.

a) Documentation-Dependent Actions by Contractor, Quantity Surveyor and Architect to Reduce Disputes.

✓ *The Contractor:*

- ▪ Re-examine all pre-contract letters, and carefully recheck all signed documents concerned prior to the execution of contract.
- ▪ Examine all pre-contract photographs of the site and/or adjacent properties and make sure that

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actual site corresponds to the drawings and levels shown on the contract drawings or agree and correct any errors before the work commences in the case of difference.

- Photograph site on the day of possession, if necessary to reveal fly-tipping, refuse dumping, flooding and any other items over which there may be subsequent argument.
- During progress, constantly compare work being executed with the itemized works in the bills to ascertain conformity in condition and/or character.
- Make certain that all depths to drainages and foundation works have been corroborated before concreting and that all extra digging for isolated soft sports and any excavation below contract datum has been agreed in writing and included in the correct nomenclature of the S.M.M.
- Keep records of materials used for filling soft sports.
- Maintain records of hours spent on pumping out water in foundations.
- Keep records of all "breaking out" of block work, masonry, timber, concrete, reinforced concrete and steel piling etc, making certain that the records were signed and agreed by both parties to the contract.
- Remeasure all provisional quantities and obtain all signed records necessary for evidence and agreement.
- Maintain records of original and revised drawings to prove facts concerning any later items of possible disputes.
- Make all notifications for claiming star rates and star items in accordance with clause 11(4), on time.
- Similarly for claims under clause(s) 1(2), 11(6), 12, 21, 23, 24, 26, 27, 28, 29, 32, 33, 34 and for arbitration 35 etc.
- Make weekly or daily returns of all labour, sub-contractors, specialist plants and materials involved for cost records or day works.
- Keep records of all Architect certificates, instructions and variations and prompt for variation orders when the need arises.
- Obtain authority for day works and similarly overtime works.
- Confirm all Architect's oral instructions in writing
- Attend site meetings, maintain and read records of resolutions and other correspondences arising during work progress.
- Back all claims with appropriate claim clauses and maintain up-to-date price fluctuation records.
- Claim against nominated subcontractors/suppliers for loss/expense caused through their delay and other contra-charges.
- Give notices providing details as soon as actual or likely delay to progress is reasonably apparent, indicate what can be done to avoid/alleviate the delay. Notify subcontractors etc.

b) The Quantity Surveyor

The Quantity Surveyor should ensure:

- That only drawings on which the tender is based form part of the contract with endorsements certifying them as drawings on which the bills of quantities are based.
- Similar check should be extended on all other contract documents e.g. articles of agreement is fully filled as well as the appendix and preliminaries.
- Ensure that deletions/omission/ alternations to the standard condition are minimized and all amendments fully signed by both parties.
- Avoid over or under measurement of billed works and at all times comply strictly with the rules of the S.M.M.
- That bills of quantities reflect all agreed amendments to rates with any agreed percentage adjustment endorsed by the parties before a witness(es).
- That prescribed copies of the contract documents are issued to the contractor.
- During post award management, maintain comprehensive records that will facilitate smooth, speedy interim valuation, valuation of variations, claims, fluctuations and preparation of final accounts.

c) The Architect

- The Architect should maintain a log of what is going on, what is present on site and the apparent effect of any unusual occurrences and delays etc.
- Obtain better understanding of manufacturers' dimensions, current range of components, fixing details and the site problems of tolerances, handling and fixing.
- Become more aware of site practices, construction sequencing, continuity problems and the influence of the site environment on design and cost.
- Effect closer consultation with site management and operatives involved in construction.
- Provide explanatory notes, component details and promptly issue instructions as and when the need arises.
- Make use of feedback information and avoid over optimistic and spuriously short programmes sensitive to time and cost over runs.

d) Documentation for Contract Oversight/ Audit

Oversight and audit have become embedded in our public procurement Act. Oversight to be effective requires confluence and interface of efficient documentation by both project actors and monitoring and evaluation consultants. Monitoring consultants shall design and document project monitoring standard forms appropriate for the projects being evaluated. This shall span from project inception to the project closure and in some cases project use life (see Appendices A1-A3 and Appendix B, monitoring Standard Forms).

This underlines the need for early appointment of monitoring consultants. The information to be elicited using these standard forms include project title, contractor, contract period, elapsed time, target time, target output, performance indices; index of work done, value of work done, payment to date, cash flow index, input of beneficiary, problems and suggested solutions, performance of project participants (project consultants, in-house professionals, manufacturers, suppliers and contractors).

These documentations by monitoring consultants to be effective, require formalizing of relationship with all project participants in order to ensure objective data collection.

Project monitors shall work in collaboration with other project consultants, in-house project co-ordinators or desk officers, the contractor, the project co-ordinating taskforce members, other specialist consultants, funding and donor officials by assigning clearly defined duties and assessing their capabilities and outputs from time to time.

e) *Documentation of Action Plans, Milestones and Construction Programme*

Monitoring consultants' documentation shall break down the project tasks into stages and milestones to facilitate monitoring (see Appendix A3 and Appendix B). These will enable the evaluation of progress and financial position periodically for effective audit report.

Adhering to documented dates of site visit enables the project monitors to accredit or refute the reports of project consultants regarding size of time and cost variances of projects. This facilitates effective documentation of breach of work ethics and its transmission to the client and possibly to statutory authorities.

Documentation for monitoring is synonymous with generation of standardized data collection format, to facilitate assessment of performance of each project/participant at pre-determined stages in relation to time performance, cost performance, cash flow levels, and quality performance as illustrated in appendix B, tables 1-13. This will ensure financial discipline, avoid/reduce delays, cost overruns and project abandonment, increase output of construction industry and add value to the national economy.

IV. Conclusion And Recommendation

The study concludes that for documentation to be effective in realizing project success, it must span amply through four documentation phases of pre-tender documentation, tender documentation, contract administration documentation and monitoring/evaluation documentation.

It posits that success of physical and social infrastructure development contracts must obtain through control and that control cannot be achieved without project monitoring which in itself relies on effective documentations to add value to the economy.

For efficient and effective project documentation to emerge, project partnering spirit (openness) must be exhibited by all project participants/stakeholders. Contract cash flow documentations must be accurate, consultants and contractors must be less insular and exercise/disclose accurate valuations, and authentic verifiable cost expenditure profile.

These are sina-qua-non for the emergence of contract performance measuring metrics and monitoring standard forms to support proper contract oversight/audit processes.

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Appendix A

(A1) Project Preparation Monitoring Documentation Guide

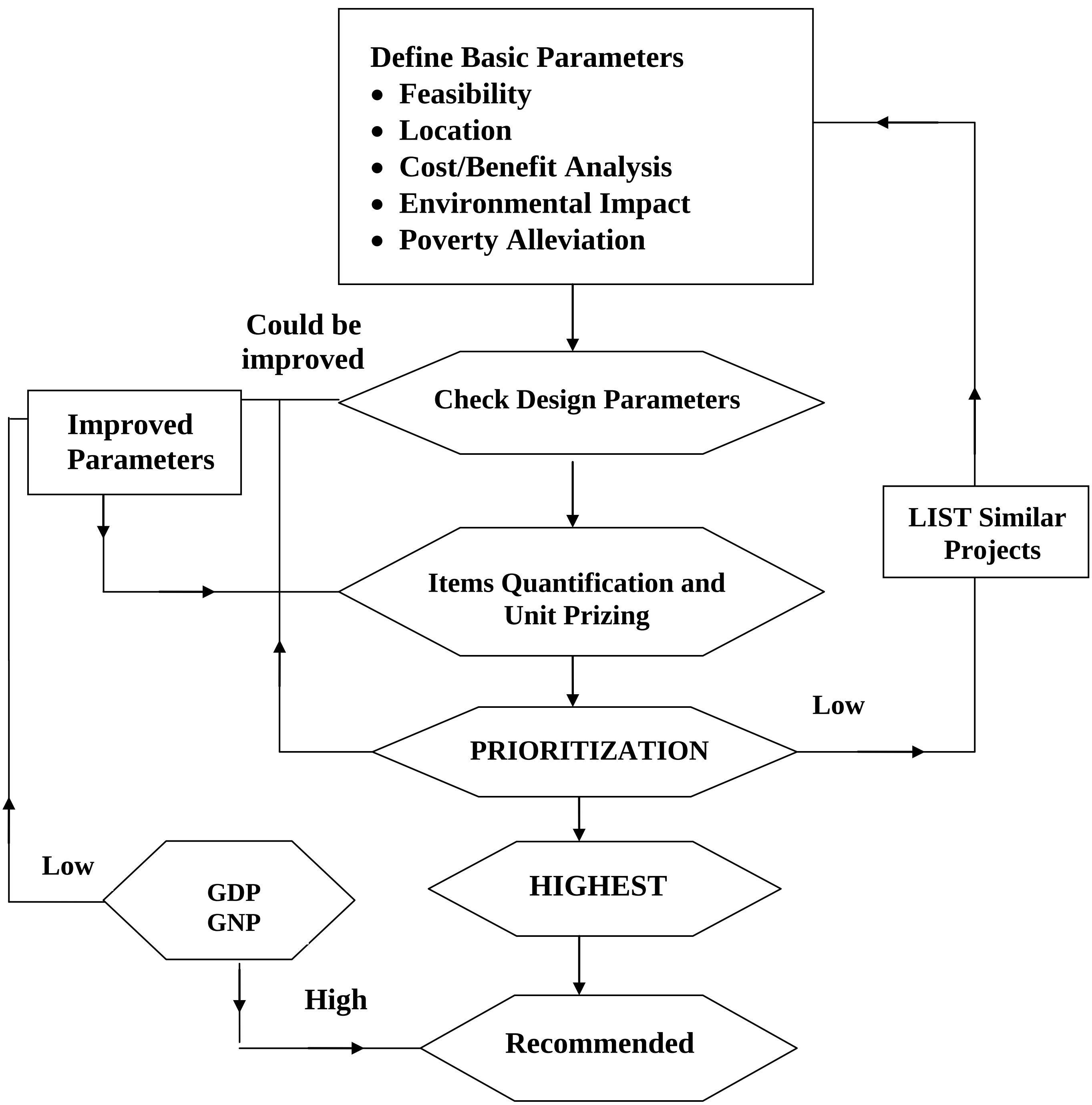

Figure 1

Source: Authors' Proposal/ Report (Ajator, etal 2007)

(A2) Project Procurement Monitoring Documentation Guide

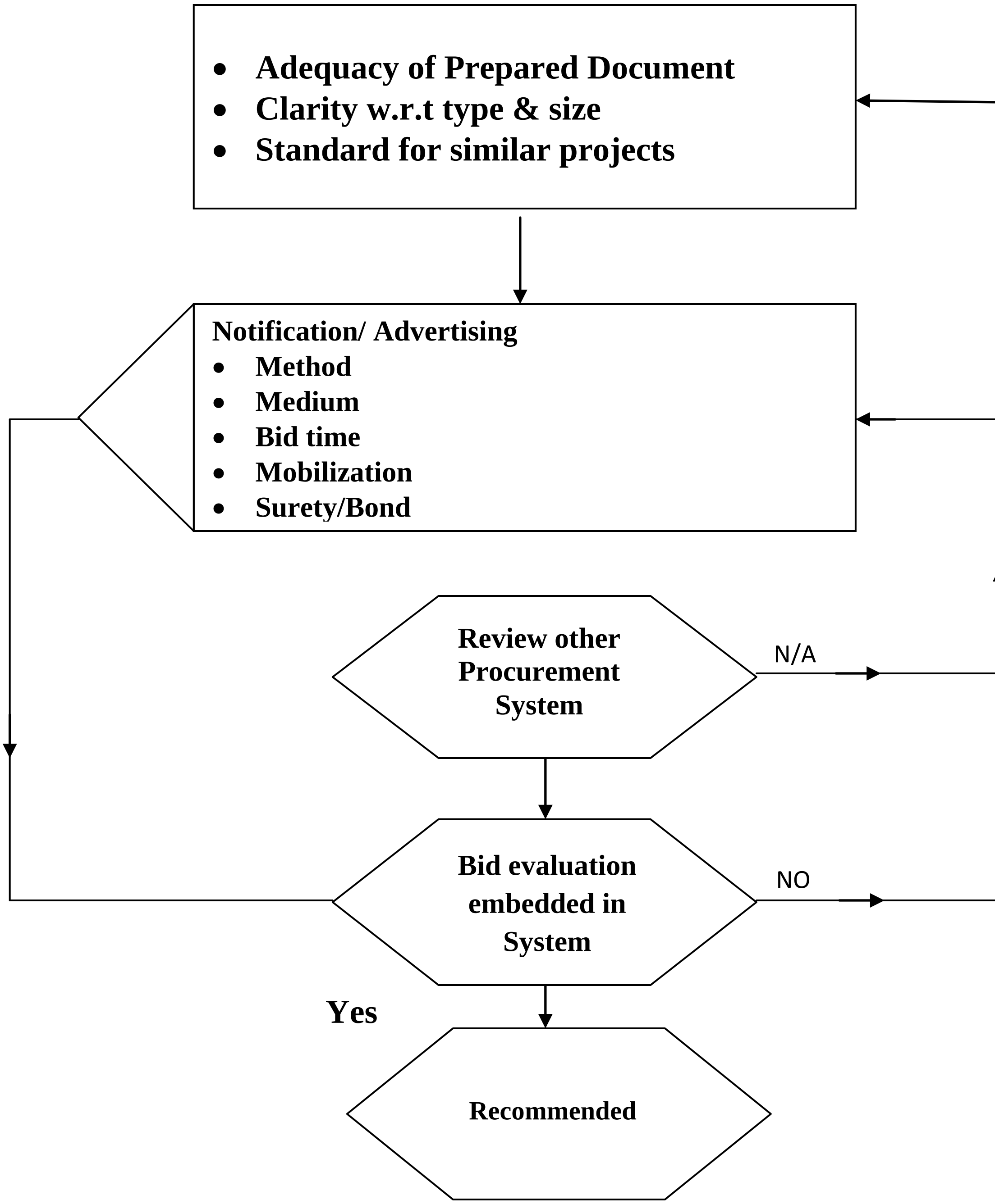

Figure 2

Source: Authors' Proposal/ Report (Ajator etal, 2007)

(A3) Documentation Action Steps for Monitoring of Project Implementation

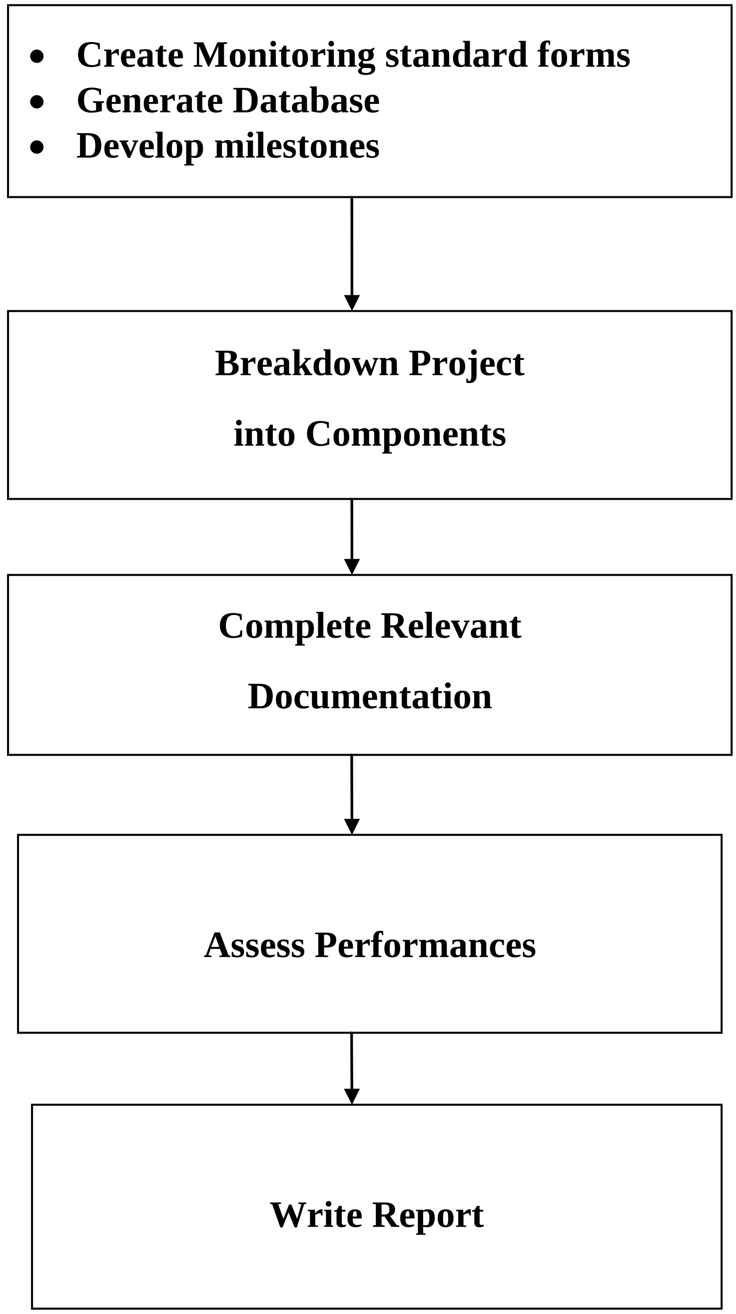

Figure 3

Source: Authors' Proposal/Report (Ajator etal, 2007)

Appendix B: Monitoring Standard Forms

Month: **Date**

Sub sector **Related Sectors**

LGA **Zone**

PARTICULARS:

Client: **Zonal Consultant**

Contractor: **Beneficiary Agency**

Contract Sum: **Commencement Date** **Time Elapsed**

Contact Period: **Liquidated/ Ascertained Damage**

SPECIAL STATEMENTS:

Certified Contract Sum: **Payment Certified to Date:**

Fluctuation/ Variation: **Actual payment to Date:**

Inspection Held: **Value of outstanding works**

Table 1: Action Plans/ Milestones: Duration and Performance

S/N	STAGES	TARGET (WEEKS)	ACTUAL (WEEKS)	REMARKS
1				
2				
3				
4				
5				
6				
Cumulative to date				

Table 2: Action Plans/ milestones; information: cost and performance

S/N	STAGES	TARGET (=N=)	ACTUAL (=N=)	REMARKS
1				
2				
3				
4				
5				
6				
Cumulative to date				

Table 3: Action Plans/ milestones; information: cash flow and performance

S/N	STAGES	TARGET (=N=)	VALUE OF WORK DONE (=N=)	REMARKS
1				
2				
3				
4				
5				
6				
Cumulative to date				

Table 4: Action Plans/ milestones; information: Quality and performance

S/N	STAGES	TARGET (=N=)	ACTUAL	REMARKS
1				
2				
3				
4				
5				
6				
Cumulative to date				

UA" Unacceptable O: NS Not Satisfactory I, FS = Fairly Satisfactory 2, SA-Satisfactory-3, VS- Very Satisfactory 4.

Table 5: Variations

S/N	DATE	ORDER NO.	DESCRIPTION	AMOUNT CLAIMED	AGREED COST	REMARKS
1						
2						
3						
4						
5						
6						
Cumulative to date						

Table 6: Fluctuations

S/N	DATE	LABOUR OR MATERIALS	DESCRIPTION	AMOUNT CLAIMED	AGREED COST	REMARKS
1						
2						
3						
4						
5						
6						
Cumulative to date						

Table 7: Evidence of Beneficiary Interest/ Co-operation in the project

S/N	DESCRIPTION OF INTEREST	REMARKS
1		
2		
3		

Table 8: Documented Problems and Solution

S/N	NATURE OF PROBLEMS	SOLUTIONS DEVISED	REMARKS
1			
2			
3			

Table 9: Performance/Efficiency of Projects Participants'

PERFORMANCEE INDICATOR	CONTRACTORS	SUB CONTRACT-ORS	MANUFACTURERS	SUPPLIERS	PC	CLIENT
Adherence to time						
Quality of work Compliance with deliveries						
Quality of staff (Qualification)						
Adequacy of staff (No)						
Co-operation with other participants						

Ability to put project on course						
Adequacy of project reports Timeliness of project reports						

UA Unacceptable O: NS Not Satisfactory I. FS = Fairly Satisfactory 2, SA- Satisfactory:3; VS- Very Satisfactory 4.

10. General Remarks and Comments on Submission from Project Consultants (PC).

11. Comment by Project Desk Officer (PDO)

    a. Signature & Date ________________

    1. PDO

12. Comment by Beneficiary Project Officers (BPO)

    a. Signature & Date ___________________

    1. BPO

13. Comment by Project Monitoring and Evaluation Unit (PMEU)

    Signature & Date _____________________

    PMEU

Project Monitoring and Evaluation Unit

Table 10: Summary of Programme Monitoring Report ………….Sector

Month: …………………. Date………………..

PROJECT TITLE/ CONTRACT SUM ETC			THIS MONTH			CUMULATIVE					Comments
	Contract period (Month)	Time Elapsed (months)	Target Output	Actual Output	Perf. Index	Forecast output	Actual output	Perf. Index	Value of payment Work Done	Cash flow Index	

Perf = Performance PMU 04

Project Monitoring/Evaluation Unit

Table 11: Capacity Utilization and Procurement of Equipment for Public Works by Contractors and Manufacturers

Sector

S/N	Name of Organization	Value of total No. of Equipment		Capacity Utilization	
	Contractors, manufacturers	Prior Engagement ₦	Current value ₦	Prior Engagement %	Current Utilization & %

PROJECT MONITORING/EVALUATION UNIT

Table 12: Personnel Utilization: Consulting Firms for Public Projects

Sector

				No. of Personnel			
S/N	Name of Firm	Address	Specialization e.g Arch. Engr. Q/S etc	Prior to Engagement		Current	
				Professionals	Others	Prof.	Others

PROJECT MONITORING/EVALUATION UNIT

Table 13: Personnel Utilization for Public Projects: Contractors, Manufacturers and Suppliers

Sector

				No. of Personnel			
S/N	Name of Firm	Address	Specialization Building, Civil Manufacturers etc	Prior to Engagement		Current	
				Prof.	Others	Prof.	Others

Source: Author's Proposal (Ajator, etal 2007)

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Challenges in Implementing Public Private Partnerships (PPPs) Projects in the Road Sector in Zambia

By Raivy Namalala Chilala & Dr. Michael Mulenga
University of Zambia

Abstract- The uptake of Public – Private Partnerships (PPPs) in the road sector in Zambia has been limited, despite the Government of the Republic of Zambia's initiatives as far back as 2009 when the PPP Act was enacted. The paradox is that there was no study that had been conducted to determine the challenges in the implementation process. This study sought to find out the main challenges in the implementation process and to offer possible solutions. To achieve this objective, the researcher carried out a detailed literature review and utilized a purposively sampled population of experts in a semistructured interview and questionnaire survey. The Statistical Package for Social Sciences (SPSS) and the Pareto's Principle were used to analyse the collected data. The study confirmed the prevalence of implementation challenges in the road sector in Zambia. From the fourteen identified and short-listed implementation challenges, the study identified nine as the major challenges requiring attention, with the three leading ones being: (1) non-financial viability of the concessions due to low traffic volume; (2) lack of time, resources, knowhow and authority within the staff of implementing agencies to originate and implement PPPs; (3) inconsistent and unclear PPP Policy.

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CHALLENGESINIMPLEMENTINGPUBLICPRIVATEPARTNERSHIPSPPPSPROJECTSINTHEROADSECTORINZAMBIA

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Research | Diversity | Ethics

Challenges in Implementing Public Private Partnerships (PPPs) Projects in the Road Sector in Zambia

Raivy Namalala Chilala α & Dr. Michael Mulenga σ

Abstract- The uptake of Public – Private Partnerships (PPPs) in the road sector in Zambia has been limited, despite the Government of the Republic of Zambia's initiatives as far back as 2009 when the PPP Act was enacted. The paradox is that there was no study that had been conducted to determine the challenges in the implementation process. This study sought to find out the main challenges in the implementation process and to offer possible solutions. To achieve this objective, the researcher carried out a detailed literature review and utilized a purposively sampled population of experts in a semi-structured interview and questionnaire survey. The Statistical Package for Social Sciences (SPSS) and the Pareto's Principle were used to analyse the collected data. The study confirmed the prevalence of implementation challenges in the road sector in Zambia. From the fourteen identified and short-listed implementation challenges, the study identified nine as the major challenges requiring attention, with the three leading ones being: (1) non-financial viability of the concessions due to low traffic volume; (2) lack of time, resources, knowhow and authority within the staff of implementing agencies to originate and implement PPPs; (3) inconsistent and unclear PPP Policy. Based on the research, it was recommended that for PPP Projects to be effective in the road sector in Zambia, there was need for implementing agencies to categorize the non-economically and economically viable toll roads and incentivize the former as part of the long term solution. Two PPP Models were recommended to encourage investment in the road sector in Zambia: the Design Finance Build and Transfer Model for non-economically viable Projects and the Design Finance Build Operate and Transfer Model for economically viable Projects.

Furthermore, the study recommended capacity building in all implementing agencies and creation of specialized 'swat teams' to work with implementing agencies on specific transactions as 'quick wins' solution for PPP projects in the road sector.

I. Introduction

This study was necessitated by limited presences of PPPs in the Road Sector in Zambia despite the Government of the Republic of Zambia's (GRZ) initiatives as far back as 2009. Globally, developed countries such as the United Kingdom (UK), France, Japan and Singapore; the BRIC countries like China and India and other rapidly/or developing Asian countries such as Indonesia, Malaysia, South Korea, Hong Kong, Australia and Thailand among others, have generated a lot of interest in PPPs/ Private Finance Initiative (PFI) in their quest to generate additional sources of capital and/or as a means of enhancing value for money for enhanced public service delivery (Lengwe, 2014)'.

Similarly, European Investment Bank (EIB) in 2010 reported a growing interest in the use of PPP within Europe for the period of 1990 – 2009 as depicted in Figure 1.

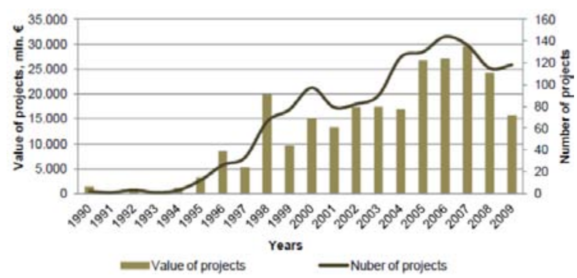

Figure 1: European PPP Trend, 1990-2009, Source: Adopted from EIB

In Africa, Zimbabwe and South Africa have an importance experience in PPPs in the road sector. Unlike Zimbabwe and South who have implemented PPP projects in the road sector, Zambia has never executed a PPP transaction in the road sector. Zambia's exposure to PPPs had not been in the road sector. The measures in place to improve the road network such as Link Zambia 8000, Pave Zambia 2000, Lusaka 400 and Copper belt 400 were all on the government balance sheet. However, the rate of investment in the road sector was inadequate to meet the demand for good road network. Zambia's population was growing at a rate of 3.1% per annum (CSO, 2017), but the pace of infrastructure development was slow, resulting in the infrastructure gap.

The infrastructure gap and its negative impact on economic growth, job creation and social cohesion in Zambia, had been conspicuous for many years. Improved infrastructure in the Road Sector in Zambia was a necessary condition for successful economic growth. However, the GRZ had been experiencing a financial crisis. Worse still, most road projects under

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implementation were on GRZ balance sheet and could not devote an increased capital expenditure to accelerate public infrastructure delivery. Debt financing was not an option either due to lack of fiscal space. The paradox was that there was no study that had been conducted to determine the challenges in the implementation process of PPPs to bridge the financial gap.

Specific Objectives of the study were:

1. To establish the Road Projects under PPP in Zambia;
2. To find out the challenges faced in the implementation of PPPs in the Road Sector in Zambia; and
3. To recommend the possible solutions required to mitigate the challenges faced.

II. Significance of the Study

The Research was significant because its findings could be used to refine PPP models in the Road Sector in Zambia. It provided a feed back to Policy Makers on what could be done to make PPPs successful in the Road Sector in Zambia.

a) *Operational Definitions*

There is no single definition of the term "public private partnership". The term should be viewed as a spectrum of possible relationships between public and private actors for the co-operative provision of traditionally public-domain services (Li, 2000).

Scope: This study was limited to PPP Projects in Road Sector in Zambia.

III. Conceptual Framework

Public – Private Partnership (PPP) is a tool of governance. All over the world, many countries use this governance method to manage public infrastructure (Massoud et al 2002). This study used the concept of New Public Management to conceptualize the challenges in the implementation of PPPs in the Road Sector in Zambia. New Public Management (NPM) can be defined "as a body of managerial thought or as an ideological thought system based on ideas generated in the private sector and imported into the public sector" (Larbi, 1999).

Through NPM, public services are carried out by the private sector with structural, organizational and managerial changes. Palmer (2009) argues that NPM focuses on the management of public services by the private sector with management changes to maximize efficiency and profitability. The transfer of such responsibilities from a Public institution to a private institution is facilitated by formation of a PPP transaction. However, PPPs (dependent variables) depend on other variables (independent variables) to flourish.

This study investigated the presences of such independent variables in the implementation process of PPP Projects in the road sector in Zambia. Fourteen (14) independent variables were identified and condensed from the literature view and the researcher's own observation. The absence of such independent variables in the implementation process was noted as a challenge.

Figure 1 shows the conceptual framework and the interaction of variables.

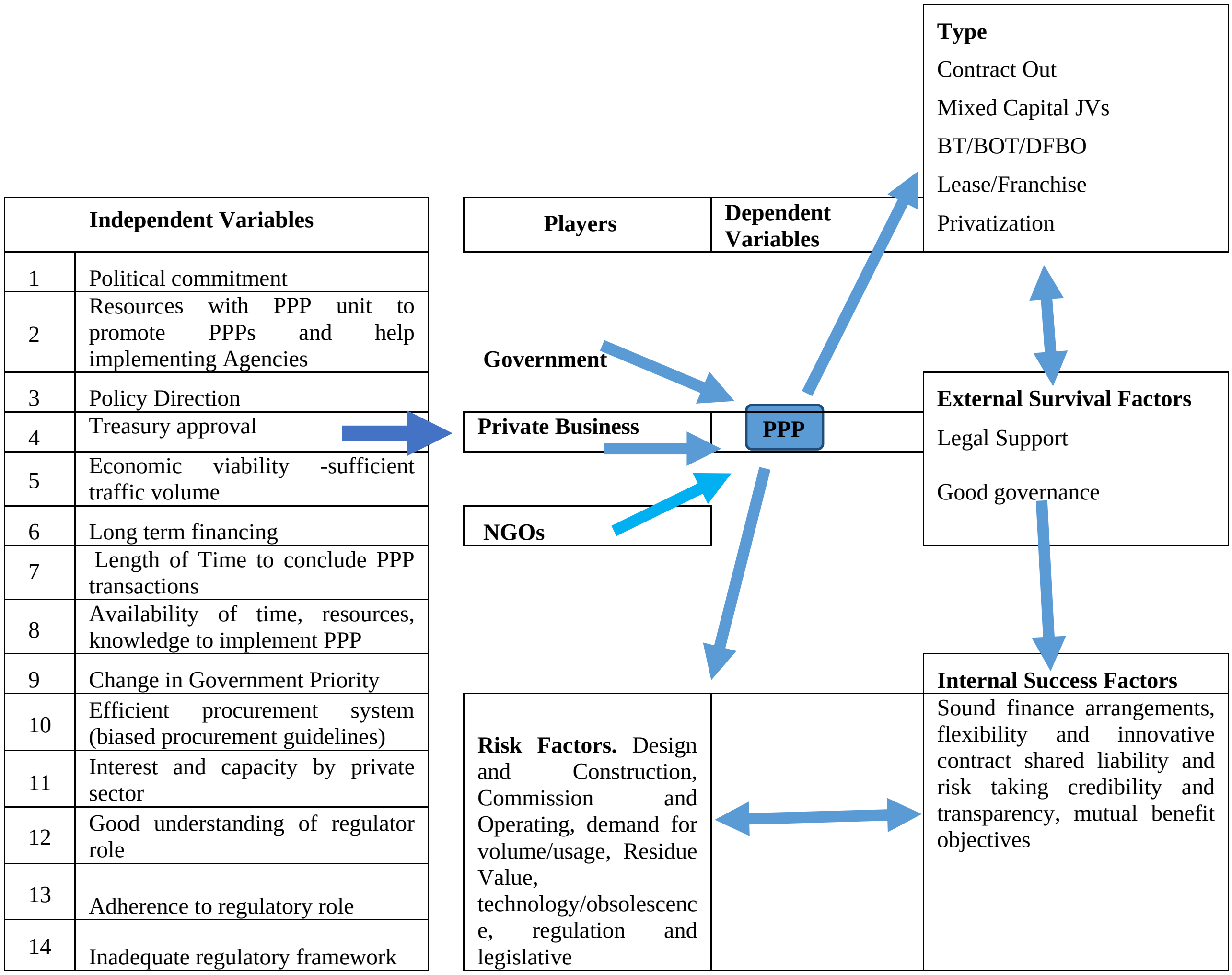

Figure 1: Conceptual Framework

IV. Research Design

The study involved a field survey which was non- experimental in design. The Researcher had no control over or manipulated independent variables, but measured the variables and their effects using statistical methods. The study showed the cause and effect relationship between variables which impact on PPPs in the Road Sector in Zambia.

Quantitative methods were used in order for the Researcher to collect statistical information about PPP road funded Projects and challenges experienced. Qualitative method was used in order to collect information which could not be obtained using quantitative method. The use of quantitative and qualitative methods was required because the study required several methods to capture adequate data in order to achieve desired results. The Researcher used both primary and secondary data. Primary data was obtained using questionnaires and interviews while secondary data was obtained from journals and books. The tool that was employed in the initial identification process of respondents was institution to institution survey. The Researcher had no control over the variables but merely reported the findings of the variable under investigation.

a) Sampling Frame

In Zambia, there were six (6) institutions involved directly or indirectly in road construction and maintenance. These were:

1. Road Development Agency (RDA) which was the overall road authority whose mandate is to design, construct and maintain the road network in Zambia;
2. National Road Fund Agency (NRFA) which was involved in resource mobilization and financing of Projects;
3. National Council for Construction (NCC) which dealt with registration of contractors and regulation of the construction industry in Zambia;
4. Road Transport and Safety Agency (RTSA) which dealt with road safety;
5. The Ministry of Infrastructure and Housing was responsible for the road sector policy; and,

6. PPP Unit which was the institution mandated for formulation of PPP policy and guidelines among other responsibilities.

The population size for experts in these institutions were RDA-101, MHID-56, NRFA -9, NCC-27, PPP Unit - 8 and RTSA-12, making a total population size of 213. It was from these institutions that 28 respondents (experts) were drawn to make a sample of 28.

The study included also 7 management staff from 5 different private institutions: Consultants; Contractors; Banks; Insurance Companies and National Pension Scheme Authority (NAPSA) who were identified as having participated in PPP transactions in the Road Sector in Zambia. This was because this category was the custodian of finances which gave an insight into the study. The findings were therefore generalized to PPPs in the Road Sector in Zambia.

b) Sample Size

For ease of generalization of the results to the road sector in Zambia, the study had a sample size of 35 respondents drawn from the key Government Institutions responsible for road maintenance and construction in Zambia and the PPP Unit. It also included 7 key informants from the private sector.

c) Sampling Procedure

To get information from the 35 respondents, this study used expert sampling which was non-probabilistic. Expert sampling is a sampling technique where respondents are chosen in a non-random manner based on their expertise on the subject being studied. The rationale was that since experts were very familiar with PPP Projects in Zambia, their opinion would be credible. Purposive sampling was used to collect information from seven key informants from the private sector.

V. Research Instrument

Questionnaires were used for collection of data. The questionnaires were suitable because the respondents were educated and did not need an interpreter. It gave the respondents enough time to think over the questions before attempting to answer. It was also convenient for use in data analysis using statistical methods for data collection.

Face to face interviews were used to gather information that needed clarification by the respondents so as to get further insights on some issues that were unclear in the questionnaire, and to help come up with a detailed report. Thus, face to face interviews were used when getting information from key informants.

VI. Data Analysis

Qualitative and quantitative techniques were used in analysis of data. The responses from questionnaires were analyzed using the Statistical Package for Social Sciences (SPSS) and the Pareto's Principle. The results generated using SPSS were interpreted quantitatively. Content analysis methods were used to analyze qualitative data from the interviews conducted.

a) Ethical Aspect

The Researcher got permission from Controlling Officers to conduct research in their respective institutions. The Researcher wrote letters to respondents requesting for their participation in the study. Participants that agreed to take part in the research were assured of the right to maintain their privacy. Participants were also assured of the ethical boundaries such as anonymity and confidentiality.

b) Limitations of the Study

The results from the study were not generalized to other sectors which implemented the PPP programs in Zambia because expert sampling was used, which is a non-probability sampling.

VII. Results

The Study revealed that there were no PPP projects that had been implemented in the road sector. The only notable concession in the road sector was Kasomeno Mwenda agreement which was signed in August 2016 but concessionaire had not mobilized one year later. Thus, it was concluded that there were no PPP projects that had been fully implemented in the road sector in Zambia.

The study confirmed the prevalence of implementation challenges in the road sector in Zambia. From the fourteen (14) identified and short-listed implementation challenges, the study identified nine (9) as major and requiring attention using the Pareto principle or the "80-20 rule. Pare to principle states that 20% of the population controls 80% of the wealth. The major challenges were: (1) Non-financial viability of the concessions due to low traffic volume; (2) lack of time, resources, knowhow and authority within the staff of implementing agencies to originate and implement PPPs; (3) Inconsistent and unclear PPP Policy (4) Non availability of long term financing; (5) PPPs take too long to materialize; (6) Lack of Interest by the private sector to implement PPP Project; (7) Low Interest from the private sector to take on PPP Projects due to unstable economic environment; (8) Lack of funds and treasury approval; and (9) Low political commitment.

Using the Pareto's Principle, the study identified the other five (5) challenges as insignificant. These were:

1. Inadequate understanding of the Regulator role by PPP unit, technical committee and the council at 4.7%;
2. Change in priority by Government at 4.2%;

3. Lack of Adherence to the regulatory framework by road authorities at 4.2%;
4. Biased procurement guidelines towards traditional methods at 2.4%; and,
5. Inadequate regulatory framework at 2.4% of the respondents.

The results showed that the gratest challenge for implementation of PPPs in the road sector in Zambia was lack of commercial viability resulting from low traffic volume. It was however reported that non commercial viability of the consessional transaction could not be a stambling block to PPPs in the road sector.

a) Long Term Recommendations

It was recommnded that as a long term measure the implementing agencies should:

1) Categorize PPP transactions as non-economically or economically viable toll roads and incentivize the former with one or a combination of the following benefits:

a. *Viability Gap Financing:* A budgetary fund to provide financial subsidy for Projects that have high socio-economic value but are not sufficiently commercially viable to be delivered on a PPP basis. A certain percentage of the total Project cost can be subsidized by the Government either as part of a capital contribution during construction or in the form of annuity payments during operation. To this effect there is need to review the PPP Policy framework to make such provisions;

b. *Fiscal Incentives:* There was need to make provisions permitting PPP investors to benefit from various fiscal incentives such as reduced import tax on capital; goods; and various tax holidays to reduce the cost of implementing the Project and to enhance viability of Project;

c. *Special Incentives (Non-Fiscal):* Any specific Project may get special incentives or other non-fiscal incentives to support the implementation of policy objectives or to enhance the ease and efficiency of delivering the Project. These may include exemption from specific provisions related to insurance regulations, banking regulations and foreign exchange regulations; and,

2) Build capacity in all implementing agencies. The respondents indicated that PPP process was a complex one which required a combination of special skills mix in financial analysis and modeling, transaction structuring, commercial legal expertise, sector knowledge and transaction management which were nonexistent in some implementing agencies.

b) Short Term Recommendations

The study recommended the following short term measures to be implemented by implementing agencies:

1) Creation of dedicated PPP Sub-Units in the implementing agencies that would be staffed with trained staff to handle PPP projects.
2) Creation of specialized 'swat teams' to work with implementing agencies on specific transactions.

From the results, economically viable concessions were recommended to take Design-Build-Finance-Operate- Maintain while non-economically viable should take Build-Operate-Transfer (BOT) with various inceptives.

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I owe my sincere gratitude to the individual respondents who contributed to making this research Project a reality.

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Mechanical Properties and Microstructures of Regenerated Cement from Waste Concrete

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Abstract- It has been a long time since humans started using waste materials in engineering applications. This approach not only reduces the yield of waste, while minimizing the costs of disposal but also limit the cost of new materials. In the field of construction, the reuse of waste concretes has been a strong research in recent years. However the processing of the wastes normally involves complicated processing and lab equipment. In this report we crush and dehydrate waste concretes with normal lab facilities and re-make the cement composites. The waste concretes were crushed and dehydrated at two temperatures, 1280 and 1400 ˚ C. To balance the concentration of silica and lime, extra lime at 28.5% and 16% were added to the waste concretes. The resultant materials were evaluated with respect to the chemical composition, mechanical properties, and microstructures. It is concluded that the material dehydrated at 1400˚C and containing 28.5% lime presents the best mechanical performance. This report presents a simple and inexpensive method to reuse the waste concretes in applications such as pavements.

Keywords: *waste concrete, regenerated cement, mechanical properties, microstructures.*

GJRE-E Classification: *FOR Code: 090506*

MECHANICALPROPERTIESANDMICROSTRUCTURESOFREGENERATEDCEMENTFROMWASTECONCRETE

Strictly as per the compliance and regulations of:

Mechanical Properties and Microstructures of Regenerated Cement from Waste Concrete

Yileng Du [α] & Hongjuan Zuo [σ]

Abstract- It has been a long time since humans started using waste materials in engineering applications. This approach not only reduces the yield of waste, while minimizing the costs of disposal but also limit the cost of new materials. In the field of construction, the reuse of waste concretes has been a strong research in recent years. However the processing of the wastes normally involves complicated processing and lab equipment. In this report we crush and dehydrate waste concretes with normal lab facilities and re-make the cement composites. The waste concretes were crushed and dehydrated at two temperatures, 1280 and 1400˚ C. To balance the concentration of silica and lime, extra lime at 28.5% and 16% were added to the waste concretes. The resultant materials were evaluated with respect to the chemical composition, mechanical properties, and microstructures. It is concluded that the material dehydrated at 1400 ˚C and containing 28.5% lime presents the best mechanical performance. This report presents a simple and inexpensive method to reuse the waste concretes in applications such as pavements.

Keywords: waste concrete, regenerated cement, mechanical properties, microstructures.

I. Introduction

As a result of modernization, new consumer behaviors generate waste with exponential increase, in a variety of different divisions of the society. Inappropriate treatment of these wastes, lead to strong negative impacts to the environment. As an applicable and effective method to deal with the waste materials, incorporating the wastes into new products can not only reduce the amount of wastes, but also reduce the cost of industrial manufacturing and production [1,2]. In the section of construction and buildings, the waste concretes cause many environmental and health issues, while more and more concretes are used these years. In the meantime, the production of cements are facing a shortage of the source materials [3-5]. The global market for construction aggregates is consistently increasing [6-9]. Development has inflicted severe damage on the environment and may endanger its sustainability. The exploitation of natural resources, in particular non-renewable resources, for construction purposes leads to millions of tons of construction and demolition waste every year [10,11]. Since most countries have no specific processing plan for these materials, they are sent to landfill instead of being reused and recycled in new construction. Of the wastes generated by the construction and demolition activities, a significant amount are the mineral waste or soils, such as excavated earth, road construction waste, demolition waste, waste rocks [12,13]. The share of mineral and solidified wastes in relation to the total amount of waste produced was very large [14-18]. A natural approach to solve these pressing problems is to re-use the waste concretes. Whilst recycling is often cited as the best way to manage waste, there are still challenges to utilize waste concretes in construction, such as the uncertainty as to its environmental benefits, low quality of the final product, owing to lack of knowledge [19-23]. Waste concrete materials are being increasingly used in constructions. Targeting engineering applicability, waste concretes should be standardized for the key parameters such as gravel size, specific gravity, water absorption ratio, and crushing values should be determined, and these aggregates should be separated from wood, ceramics, iron, and so on [24-28]. Waste concretes are mostly used as protective barrier and ground-filling material against erosion. In such large-scale projects as rebuilding roads and runways, using waste concretes will reduce the cost of removal of the debris [29-32]. The utilization of waste concretes is increasingly gaining popularity in many countries [33-35]. A lot of labs separates the hardened cement pastes from the waste concretes and then dehydrate the cement pastes at high temperature to generate the recycled cements. However, this method only uses a portion of the waste materials at low efficiency. Waste concretes are crushed and ground by means of different methods so that they could be used as concrete aggregates [36,37]. Waste concrete can be crushed into different sizes of aggregates. In comparison with normal concrete, Waste concretes have a higher water absorption ratio but a lower specific gravity. The mortar percentage used in waste concrete obtained from crushed concrete of destroyed structures was determined via linear traverse method [38-40]. Workability of concrete wastes is normally not good, and hence water amount often needs to be increased [41,42]. However, it is inevitable that cement ratio will increase in proportion to water added. Therefore, it would be desirable to obtain finer aggregates in order for a proper workability [43]. It is worth noting that the $CaCO_3$ based aggregates produce materials that share similar chemical compositions with the dehydrated cement

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paste and hence it may be a viable approach to utilize the dehydrated concretes directly and avoiding the separation step. Currently there are not many results on the utilization of the full composition of waste concretes. In this paper, we use the waste concretes with $CaCO_3$ based aggregates as the source materials to regenerate cementitious materials. This method is much easier and less cost-consuming in construction activitities. We used high temperature kiln to dehydrate the crushed waste concretes and then we studied the chemical composition, mechanical properties and the microstructures of the regenerated concretes. These results will provide guidance on the engineering utility of the waste concretes in construction.

II. Experiments

The waste concretes were kindly provided by QUATTRO UK LTD from a source of demolished building. The materials were broken and ground into powders and sieved at 800 μm. Because the full compositions were dehydrated, the materials contain a large amount of SiO_2 from the fine aggregates. For this reason we added an extra amount of lime of 28.5% or 16% in weight to balance the compositions of Ca and Si. In addition, extra Fe and Al oxides were also added at about 1%. The mixed raw materials are dehydrated at two different temperatures 1280 and 1400 °C for about 1 hour. The dehydrated materials are quickly cooled down to room temperature. The processing is presented in Figure 1.

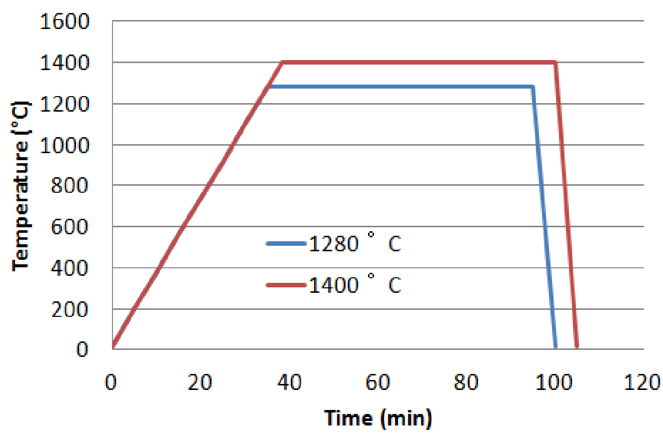

Figure 1: Temperature processing of the waste concrete

The chemical compositions were first analyzed with x-ray diffraction (XRD) with a Bruker D8 instrument. In total four different materials are prepared to compare these two parameters, as shown in Table 1. Another control sample with no waste concrete was also prepared and studies for comparison purpose.

Table 1: The four materials with different addition of $CaCO_3$ and dehydration temperatures

Material ID	$CaCO_3$	Dehydration temp. (°C)
1	28.5%	1280
2	16%	1280
3	28.5%	1400
4	16%	1400

The mixing procedures follow the ASTM standard C305 – 14. The resulting fresh materials are cast into plastic cylinder molds with the aid of vibration. All samples were sealed and kept at room temperature and demolded on the day of testings. The samples were subject to compressive and tensile tests at three different ages, 1, 7 and 28 days, with a MTS universal test machine. To understand the mechanism behind the mechanical properties, scanning electron microscopic (SEM) images were taken on the concretes at the age of 28 days.

III. Results

a) Chemical Composition

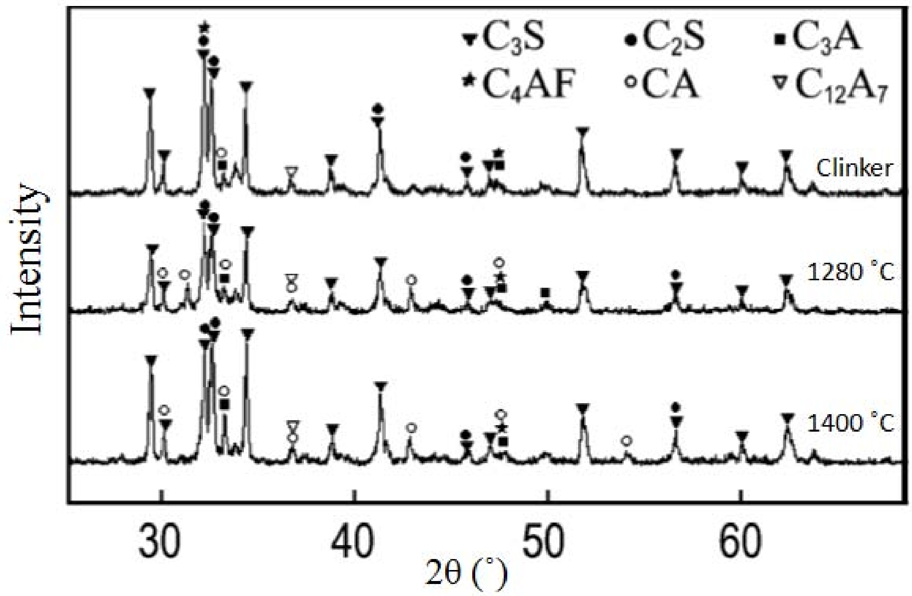

Figure 2: XRD patterns of the dehydrated cement pastes and the raw clinker

The dehydrated pastes were analyzed with XRD and the results are presented in Figure 2. It is clearly seen that the both dehydrated samples, the characteristic peaks of C_3S, C_2S, C_3A, and C_4AF are present, which are consistent with the ordinary clinkers. It is noteworthy that the phases of CSH and CH are not seen in the dehydrated materials, which means that the dehydration is completed. While it is challenging to quantitatively calculate the respective compositions of each material based on the relative intensities of the XRD peaks, it is concluded the compositions are similar among the dehydrated paste and the raw clinker. Especially there is no obvious difference between the materials dehydrated at 1280 °C and 1400 °C.

b) Mechanical Properties

The mechanical properties of the waste replaced samples were compared with studies of compressive tests and tensile tests. The results are also compared with the a control mix without waste replacement. Figure 3 shows the results of compressive strength at the three different ages. As expected, the overall strengths are decreased when the waste materials are used. And with more replacement, the strength are even lower. It is noticeable that the at higher processing temperature 1400 °C, the overall strengths are higher than 1280 °C, which is because at the higher temperature, the waste materials are more fully converted to the clinkers, allowing complete reaction between cement and water. An incomplete conversion from hydration products to clinkers may leave the unavailability of reaction spots in the matrix phase, resulting in a non-uniform microstructures. This is the reason causing the premature failures. However it should be noted that the reduction in mechanical properties were not so enormous. Especially for the samples are processed under 1400°C. The strengths are lowered less than 20%. These materials are apparently feasible for applications such as low level buildings or pavements. The cost will be significantly lower than using raw cement.

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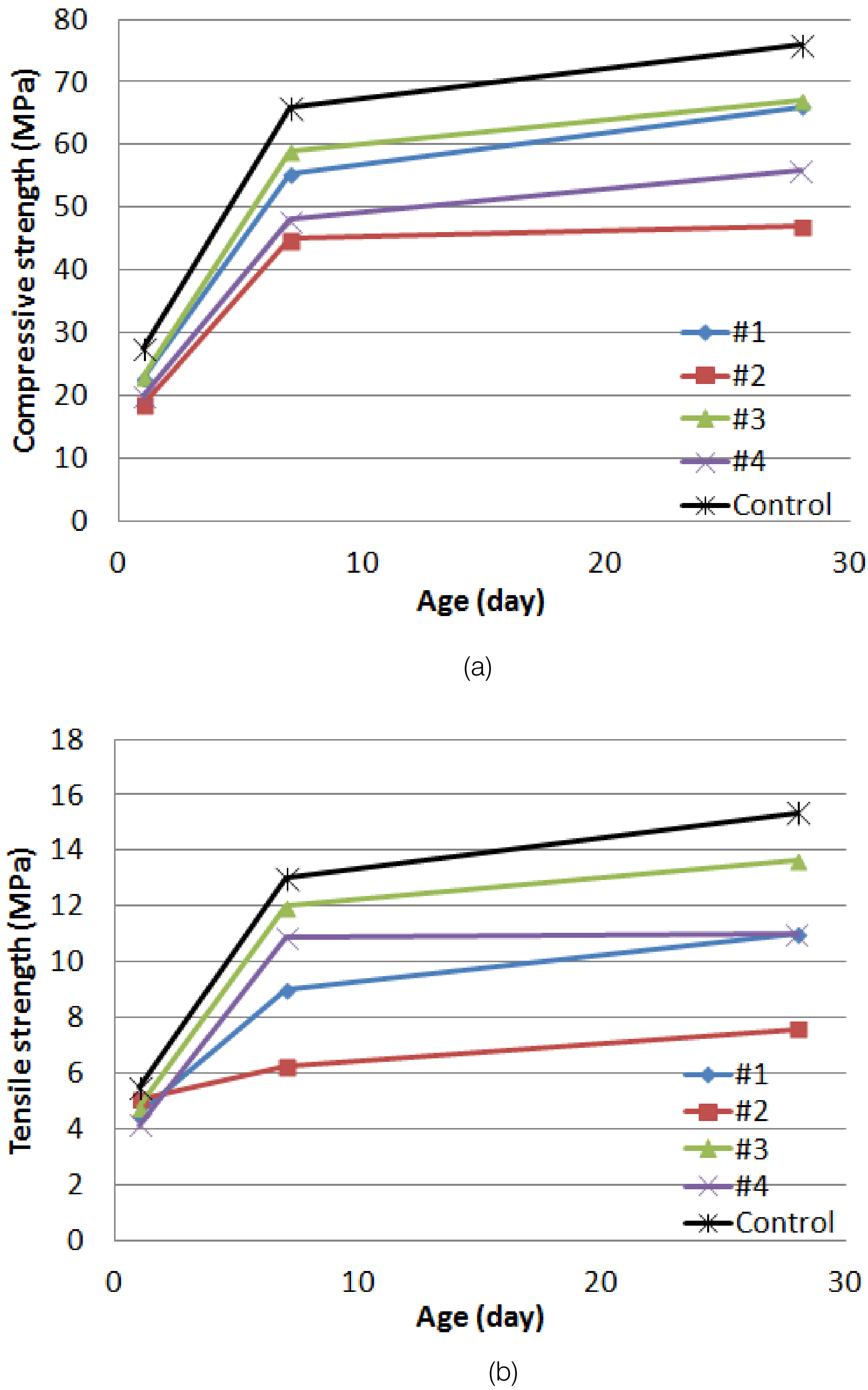
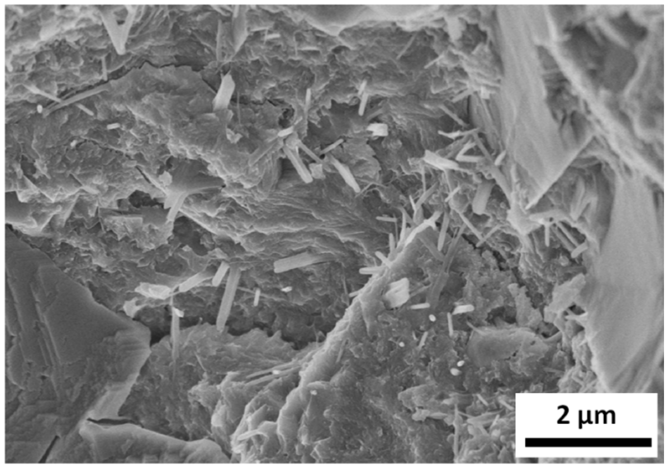
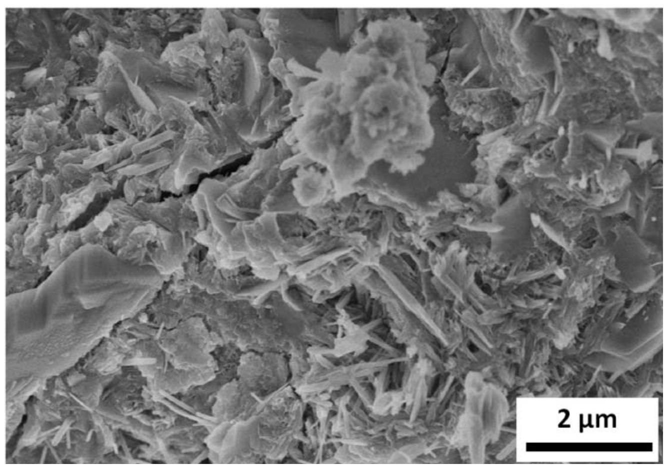


Figure 3: (a) Compressive strengths and (b) tensile strengths of the four mixtures and the control sample

c) Microstructures



(a)



(b)

Figure 4: The SEM images of hydrated cement paste at the age of 28 days for (a) control sample and (b) sample with dehydrated wastes at 1400 ˚C

The SEM images (SEI mode) of the cement paste are shown in Figure 4. The CSH and CH grains are clearly observed in the sample. The morphology of the hydration products with from the waste materials are similar with the normal pastes. In both samples, the CSH gel can be clearly observed, as well as the CH plates and AFt crystals. Comparing these two samples, it is noticed that the amount of the AFt crystals in the waste concrete sample in much less than the control sample, which may be responsible for the lower mechanical properties. It is also noted that in the sample with the regenerated cement, there is a through crack, which may be due to the weak binding between the CSH gels and other hydration products. This is also a viable mechanism to explain the diminished mechanical properties of the concretes from regenerated cement. Other than that, it seems there are no apparent differences in the microstructures between the two samples verifying the validity of using the dehydrated waste concrete to develop new materials.

IV. Conclusion

In this work, the waste concretes were processed at temperatures of 1280 and 1400 °C. The resulting dehydrated materials were directly added to mix with cement. The resulting mechanical properties are lower than those of normal concrete samples. The microstructures and CSH are also similar with the normal concretes. It is applicable to use these waste concretes for construction that does not necessitate high strengths, such as pavement and single-storey house. This work provides opportunities of using waste demolished concretes, reducing cost while having a positive impact to the environment.

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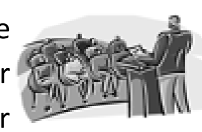

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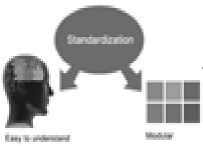

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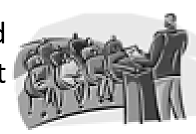

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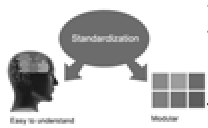

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2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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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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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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