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Aims and Scope

Global Journal of Structural Design and Construction is a peer reviewed journal published by Original Papers. It is one of the pioneering starts up journal in Civil and Structural engineering which receives high quality research works from researchers across the globe. The journal publishes original research and review papers falling within the broad field of Civil Engineering.

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Contents

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A Study of Seepage Zone Identification for Old Reservoir Utilizing Fiber Optic Cable Sensor (FOCS) Based on Passive and Active Method

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ABSTRACT

Run-off is high in the study area, due to rapid population growth and associated agricultural and other land use practices together with engineering works, which deprived the soil surface of its vegetation cover. Flooding menace is the major terrorism in Anambra state South East of Nigeria. The list of towns in the South East geopolitical zone with threatening flooding problems stretches every year. No community in the region is exempt from this terror. The entire land surface is dotted and perforated with erosion sites. Flooding is the most common of all environmental hazards and it regularly claims over 1000 lives per year and adversely affects both Agriculture and human capacity development. Data on climate, drainage, population infrastructures, and physical planning regulations were collected and extensively analyzed. The investigation revealed that climate change, or unusually high rainfall is not the only cause of the flooding problems in the studied areas. Rather, the increased urbanization, poor town planning laws in relation to the erection of buildings in flood plains, massive engineering work embarked by state government without proper studies of its environmental impact, the geology of the area, and the lack of inadequacy of storm drainage facilities in the communities are to blame. The anthropogenic and natural factors responsible for the present land use and land deterioration, in the area were evaluated.

KEYWORDS; Flooding, Geology, Rainfall, Land deterioration and Erosion

I. INTRODUCTION

The target of this paper is mainly fiber optic sensor sensors and efficacy of the active method of using fiber optic for detecting the leakage location. Because of the recent increase of extreme weather events leads toa growing solicitation of the hydraulic works of flood protection.

With Professor KiTae Chang of Kumoh National Institute of Technology and the Korean company GMG some beacons was providing for using tilt, displacement and telemetry and fiber optic cable. We naturally became responsible for leaks detection and soil moisture location with the fiber optic monitoring system in Nak Dong River and Yang Pyeong old reservoir.

The disorders affecting the protection hydraulic works are often related to the constitution and in particular to the presence of heterogeneities in the dike body. However, for the old hydraulic construction including - which might not have archives, the materials are sometimes poorly known.

Under the supervision of hydraulic construction, therefore it is necessary to characterize these materials, without putting the hydraulic construction out of service, and with less destructive possibility. Furthermore, the onset of destructive phenomena coincides with the presence of a preferential flow, which is making useful the detection of leaks along the hydraulic construction. We will present the active method of natural temperature measurements from the underground (the upstream or downstream face)through fiber optic. The technic of heating cable used for diagnosis the seepage location.

II. PROCEDURE AND INTEREST TO MONITORING OF MEASURING HYDRAULIC STRUCTURES TECHNOLOGIES DISTRIBUTED BY OPTICAL FIBE

A. General Problematic

Internal erosion, with erosion by overflows, is the main reason of rupture of the dikes and embankment dams. Leakage monitoring is thus a major component plan of the safety of hydraulic structures. The conventional method to perform monitoring of the hydraulic behavior are : Visual inspection portion and the other the auscultation via measurement of drainage flow in the structure (drainage or collectors drains channels) - which are direct measures of leakage -via the piezo metric measurements - which can provide indirect information too.

These conventional monitoring techniques are always punctual in space and time, most often they prove incapability of pathologies detection of internal erosion and are generally not able to provide sufficient accurate information in time and space on the localization of leaks and their kinetics of evolution.

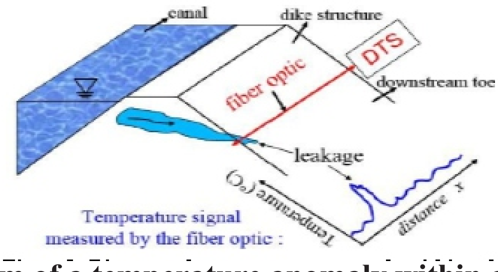

Figure 1: Diagram of a temperature anomaly within a dike leak-related

Since Several decades ago the thermometry has been proven as one of the most relevant measurement method to find leaks within Earth structures. Based on the difference in temperature between the mass if not exposed to the leak, where the temperature is regulated by the phenomenon of the limits of the work imposed heat conduction, and the area leak, where the temperature is regulated by the transport by convection of heat from water leakage (look Figure 1), conventional thermometry is used in phase of reconnaissance on works, by measurements of profiles vertical temperature in boreholes.

III. GENERAL PRINCIPLE OF HYDRAULIC STRUCTURE MONITORING BY MEASUREMENT OF DISTRIBUTED FIBER OPTICS

When sending a light pulse in a fiber optic, the strength and the temperature modify the light retro diffusion all along the fiber. The impact between the core in silica and the envelope in different silica can be measured for Brillouin as a frequency shift and for Raman as an amplitude difference. Retro diffusion provides these differences and, knowing the flight speed of the light, gives the location of phenomenon. From there, it is possible to measure strength and temperatures all along a fiber optic and to determine where the measurements are performed.

This is basically what can be done but from theory to real world there is a big gap, we will consider what can be done and how. Measure is to send a ray of light (laser beam) in a standard optical fiber installed inside a hydraulic fill work. The measuring system consists of fiber and an interrogator optoelectronics. The measuring principle is based on time domain reflectometry resolved in time.

The return signal is analyzed by the interrogator combining wave round-trip time related to the distance from the camera. Backscatter spectrum includes several rays characteristic including (see Fig. 2).

From there, it is possible to measure strength and temperatures all along a fiber optic and to determine where the measurements are performed.

- Skate Rayleigh corresponding to the fluctuations in density and composition of silica. It is used in the telecom reflectometers to verify the integrity of optical links;
- Brillouin acousto-optic-related lines depending on the temperature and the deformation of the fiber;
- Stingrays Raman molecular vibrations of silica-related. The two rays stokes and anti-stokes intensity ratio is directly related to the temperature of the fiber.

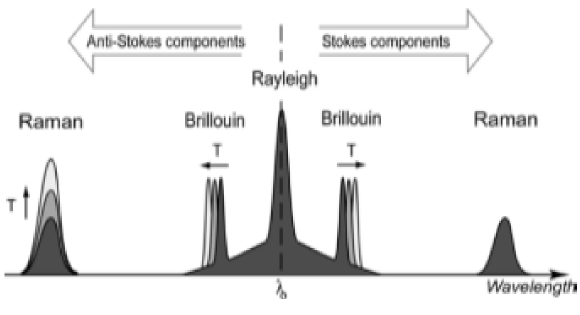

Figure 2: Retro-spread spectrum of silica (from [2])

The use of an optical fiber type multimode allows using the Raman Effect and a measure distributed temperature along this. The Optic-electronic interrogators available on the market allow obtaining a measurement of temperature all meters for a range10 km to 30 km. The accuracy of the temperature measurement is 0.1 ° C, but it degrades to the upper 10 km reaches (values of this degradation of accuracy beyond 10 km are not yet well known lack sufficient experience feedback).The time of acquisition of the measurements by step may vary from one measurement every 10 minutes to one measurement per year or even less.

Two different methods can be used for monitoring leaks by fiber optic measurement: the passive method and the method of heating, also called active method. The use of a fiber optic Single modeal lows using the Brillouin effect is: Combining the same fiber with in optic cable multi-mode allowing an independent measurement of temperature by Raman Effect and can deduct the measurements of fiber's deformation in the axis this one, expressed in macrostra in (μ, or μm/m). The calculation of deformation is performed from the following relationship:

$$\Delta V_{F0} = Cs_{F0} \times s_{F0} + CT_{F0} \times \Delta T_{F0} \quad (1)$$

With:

ΔV_{F0}, the frequency shift of Brillouin lines directly measured by the interrogator optic-electronic

Cs_{F0} andCT_{F0},parameters of altimeter;

s_{F0}, deformation of the fiber optic;

ΔT_{F0} , optical fiber temperature.

To achieve a consistent measurement we needs to be careful. Brillouin method gives both strength and temperature on same fiber optic line. To separate both measurements, one need to use a fiber sensing strength and a fiber not subjected to strength.

Thinking of a loop fiber will allow measuring the way out as strength and way back as temperature (see Fig. 3)

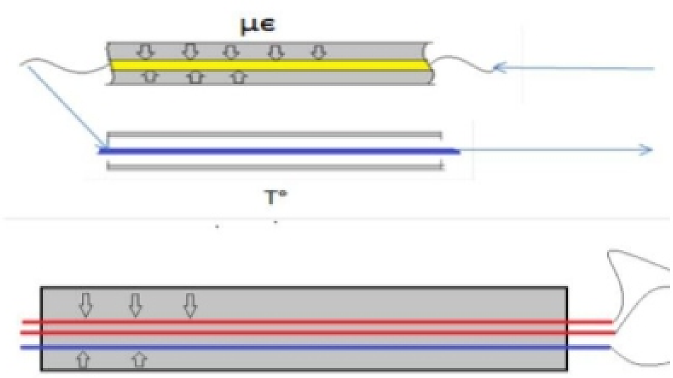

Figure 3: Brillouin and one Raman compensation

We pointed above pre-strength fiber. If the fiber is coated with silicone or other material, in the lab, Lorentzian motion will be clean but not significant. Reason why to offer a real zero or reference, the fiber must be pre-strengthen. Sheathing the fiber with a metal structure will offer a real reference, enhancing the sensitivity and avoiding zero fluctuations with whatever strength unexpected and with no relation with measurement that could occur.

B. Applications of Fiber optics

Fiber optics can be used on several types of application: natural sites like slopes, embankments, rock falls...

A lot of sites are using this technology in order to prevent disasters and this particularly in South Korea where climatology is severe with large temperature differences, heavy rain or heavy snow, earth quacks, floods and others.

Figure 4:Fiber Optic Applications

C. Principle of the leak monitoring fiber by the Active method

Heat transfer in a soil column can be described by the diffusion equation,

$$\frac{\&T}{\&t} = D(8)\frac{\&^2T}{\&z^2} = \frac{k(8)\&^2T}{C(8)\&z^2} \qquad (1)$$

Where D is the thermal diffusivity of the soil, it is the ratio of its thermal conductivity (κ) to its thermal capacity ©. These soil thermal properties are functions of soil moisture, so the objective of this feasibility study was to determine if soil temperature measurements at multiple levels are sufficient to infer soil thermal properties and hence soil moisture.

Using an approach similar to that employed by Beha gel et al. [2007], soil moisture was estimated by finding the diffusivity which gave the best fit between simulated and observed cable temperature.

This approach is to analyze the acquired raw data of fiber optic temperature measurement from data logger. The Detection of anomalies of the soil from the gross measurements heating temperature value from optical fiber just before during and after heating being generally impossible, so the use of analytical methods, based on a statistical physical approach or on signal processing approaches, is essential to correct and interpret these data. The time required for downloading data and their analysis by an engineer then varies the size of the structure, is between 3h and a full day. Not fully automated data processing is currently envisaged.

To correctly carry out these interpretations, additional measures of air temperature, water upstream of the structure and the water content are generally required. By using this active method for data analysis in Yang pyong old Reservoir graphs from experimental sites showed that the radius of a leak around the optical fiber is located 7 to 9 m and10 to 12 meters wet zone.

Methods of analysis based on the physic-statistic approach require a continuing Chronicle of data on at least 3 to 6 months to be able to provide a diagnosis on the presence or absence of leakage. With this constraint, these methods can be used to monitor the hydraulic behavior in the long term as to generate alerts in case of sudden onset of a change of State.

Some signal processing-based methods require that a Chronicle continues a few days of data to be able to provide a diagnosis on the presence or absence of leakage. These methods can then be used as well in the long term for the generation of alerts monitoring (in the latter case, the delay between the measure and its interpretation is in the order of 2 to 3 hours).

Generally, it is necessary to have a wide range of complementary methods to be able to correctly answer all the needs of the monitoring, long-term monitoring terms of the behavior of the structure.

D. Leak Detection by the active method (heating)

These days one of the most effective and promising (1) methods for the identification of leaks in dams and dikes is the method of thermal analysis.Heat transport in the body of the hydraulic structure of the Earth is described by equation of energy (1). The second and the third part of this equation describe respectively the driver transport process and advection of heat. Where the advection process is defined as the heat transfer to the mass of the water fluid.

The method of measurement with heating takes the same basic principles of distributed measurement temperature by optical fiber, using the Raman Effect presented before. The optical fiber is increasingly surrounded by copper cables heated by Joule effect over a short period of time. Electric power to the heater is 3 to 15 W/m according to studies conducted in the laboratory on a small scale. Power recommended, based on the feedback, to use this method however is 10 to 15 W/m,. The evolution of the temperature measured during the implementation of this method is shown in Figure 4 below.

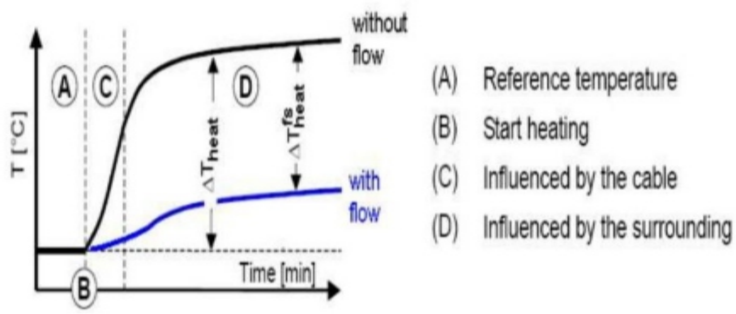

Figure 4: Evolution of the temperature of the optical fiber during a test of heating (according to [2])

A measurement of heat conducting and interpreting lasts about 3 to 5 hrs. This method does not require purchasing beforehand a history of measurements. It is therefore well suited to certain problems of monitoring on short time scale (for example: handing water to the hydraulic structure).

However, this method requires virtually, in particular for reasons of security, the presence of an intervener on site during the measurement, which limits strongly its use in situations of surveillance when fast-charging and not predictable of the structure.

Method of heating is thus well adapted to relatively low length embankment dams and channels (≤ 5 km) in particular for monitoring resetting in water or any other type of surveillance characterized by a short time scale (a few hours to a few days) and when the presence of intervening specialized on site for the operation of electric power equipment is possible.

IV. PRODUCTION AND ENGINEERING HYDRAULIC APPROACH FOR INTEGRATING TECHNOLOGY OF OPTICAL FIBER D OF DAMS AND DIKES TO RESERVOIR

Our research group with Professor KiTae Chang at kumoh National Institute of Technology leads an ongoing effort since 2years to use distributed fiber temperature measurements to monitor leaks in hydraulic structures in embankment. During this phase of research and development, experiments of leak by optical fiber monitoring were conducted according to the scheme of classical development of any new technology:

-The experiments in laboratory;

-Experiments on site controlled;

-Experiments on real sites.

These experiments helped to validate a wide range of complementary models of analysis of raw data temperature measurements from fiber developed by our research team in the context of this research effort and to specify their domain of validity. They were also allowed showing the ability of these models to detect minimum leakage between 0.1 l/min and 1 l/min, depending on the type of structure. They have also shown that this technology can be used both to monitor long-term hydraulic behavior and as a means of early warning in the event of a significant anomaly within the hydraulic structure, linked to a leak.

While me and my team member's research effort continues on the qualification of leaks and interpretation of deformation measurements, the results obtained on the location of leaks were sufficiently successful to engage an approach by step up futures lead to an industrial deployment of this technology on a part of the Structures.

The deployment of monitoring of leakage through fiber optic now follows the following process:

-Experimental phase: implemented on some real sites, installation is the scale of the work. The objective is to control the realization of the installation (quality, costs and deadlines), to validate methods of interpretation of raw data, to test human organization in charge of the operation of this surveillance, to ensure compatibility and the insertion of this monitoring data in the Information System.

- Pilot phase: the technology is deployed on various actual sites, procedures to realize the installation are defined, methods of interpretation of raw data are secured and hardened, human organization for the operation and maintenance of the system are controlled.

- Industrial phase: the technology is deployed according to the needs...

Validation of a phase and the transition to the next phase is a specific Committee on the follow-up to this deployment.

V. ANOMALY OCCURRENCE

For providing a good structure coverage with high probability to detect a failure or an event we can use several for the detection. As an example the traditional sensing method very is limited in large structures such as dam reservoir dike and it is always very difficult to define a priori where a damage can occur.

Figure 3.1 Site View of Anomaly occurrence taken by Drone

VI. SITE INSTALLATIONS OF LEAKS DETECTION BY FIBER OPTIC MONITORING

E. Monitoring by optical fiber installations so far by Kumoh National Institute of Technology

Thus having a measure distributed temperature within the hydraulics structure, positioned appropriately according to the objective to be achieved (e.g.: control with a seal control of leaks in foot of slope downstream or upstream face).

Figure 5 : Experiments on sites

The monitoring is based on the principles of Thermometry applied to leak detection: where fiber intercepts a leak, it measures a temperature regulated by the transport of heat by convection along the leak elsewhere it is conduction which controls the temperature.

Monitoring facilities of leakage through optical fiber made to date by Kumoh National Institute of Technology in the context of its program of research and development:

In the field of monitoring facilities design by fiber optic the main points for the design of monitoring facilities by optical fiber from the hydraulic structures in embankment are as follows:
- As for any installation of a hydraulic structure monitoring, it is imperative that the design of a monitoring by optical fiber facility uses as input the results of a study of diagnosis of safety of the structure. This diagnostic study should in particular to determine the level of performance of each guardrail of the structure and specify the path of (proven or potential) leaks through the structure, so that can be the ideal position of the fiber where they will have the greatest chance to intercept these leaks.
- The design of a monitoring facility must include the installation of optical fibers and the installation of additional conventional testing equipment, whose nature and positioning must be defined on the basis of proven or potential risk to monitor.
- It is necessary during the design phase of the installation of optical fibers, to validate the ability of analysis models of raw temperature data to detect temperature departures expected in the structure. For this, the designer must be able to carry out a hydraulic modeling of the work, typically using the vertical 2D finite element models representing representative cross-sections of different homogeneous segments of the structure, which allow obtaining synthetic temperature of data with consideration of anomalies of type leak. These synthetic temperature data are then used as input for the analysis of raw temperature data models and verified that these latest models are well able to detect simulated leaks. This modeling approach also allows optimizing the positioning of the fiber within the structure, by determining the position of the fiber which allows obtaining the best leak detection. Implementation of this modeling requires in most cases, the acquisition, by measurements in situ, temperature data acquired during several months, to be used for the model boundary conditions: temperature of water held groundwater temperature up and downstream of the structure, the air temperature and other possible heat the model boundary conditions.

- The choice of the materials used in the installation of optical fibers is also a milestone for the success of the installation. This choice must be based on a very good knowledge of the materials available on the market by the supervisor responsible for the design, both for optical fiber for optoelectronic interrogators. A bad choice of fiber (for example a cable whose resistance is poorly adapted to the installation on the site conditions) can be crippling for the sustainability of the installation. A bad choice of interrogator Optoelectronics (for example, a device that is not reliable) can cause strong monitoring system unavailability.

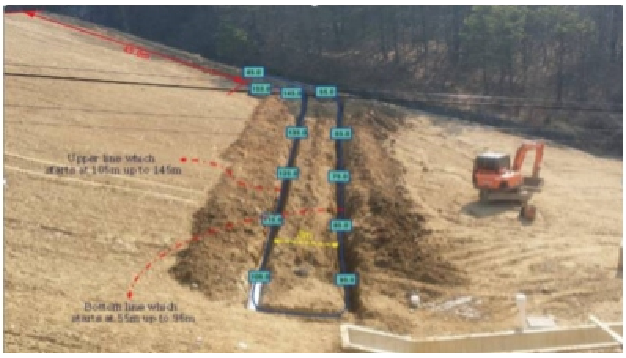

Figure 5: Fiber Optic Sensor Installation

VII. MEASUREMENT RESULTS

The temperature measurement took place from May 2015 September 2015 and information was collected at 2minutes,5minutes and 30minutes intervals.

The graphs below are by order: heating graph (on 08-15 May 2015, 03-30 June 2015, and 01-31 July 2015).We detected that changes in the temperature took place on May, and July and August2015in the range of about 88 and 96meters (Fig 6,7,8,9); we have the wet zone totally clear but more visible from the Heat graph and the visualization graph. With different month with the same condition of experimentation, temperature changes were also detected at all peak points just after 88 meter and around location 61m (Fig, 7, 8).

Warm water entered the soil first at a point that was at a height, and viewed from the filter side on the left hand edge. In the afternoon, the water drained to the front edge of the second layer on the left-hand side (Fig 8 and Fig 10).

Seepage-Heat Coupled Analysis

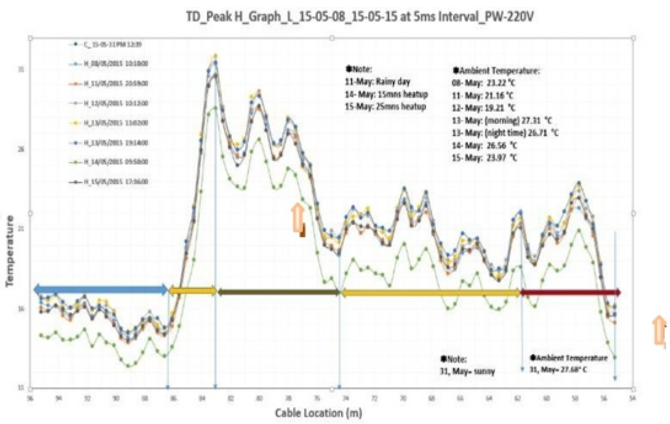

Figure 7: Graph with heat (Active method) on May 2015

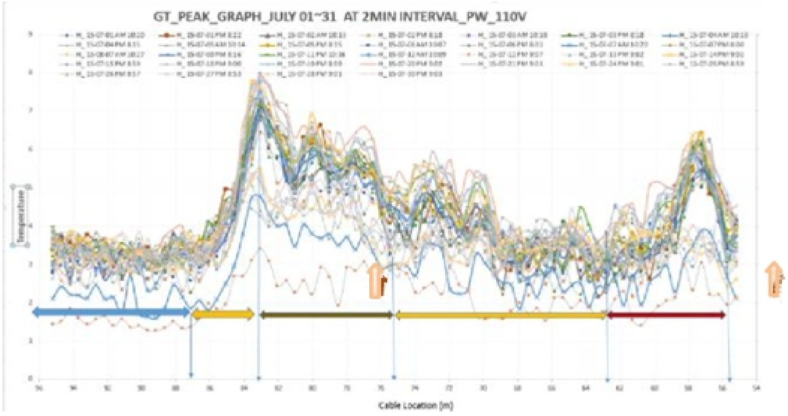

Figure 8: Graph with heat (Active method) on July 2015

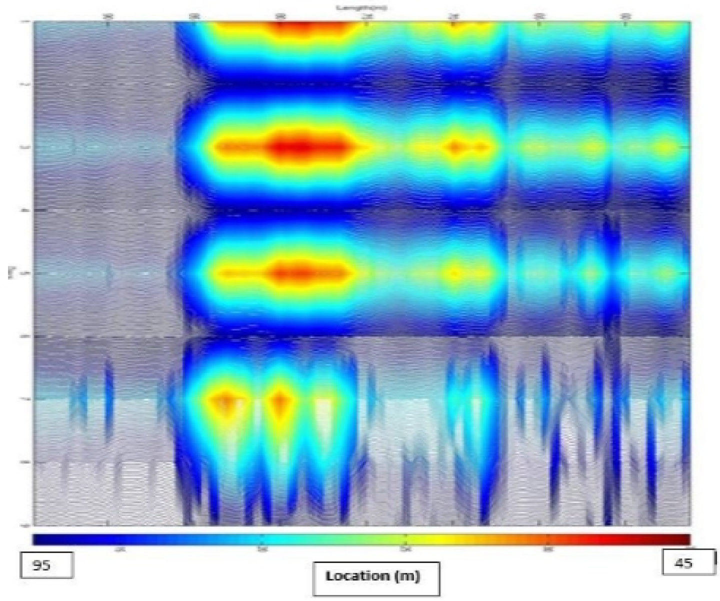

Figure 9:Visualization of raw temperature data measured by optical fiber before during and after heating of side test Easting: longitudinal axis of the dam. Ordinate: transversal axis of the dam Temperature Profile over Time on Lower Fiber Line

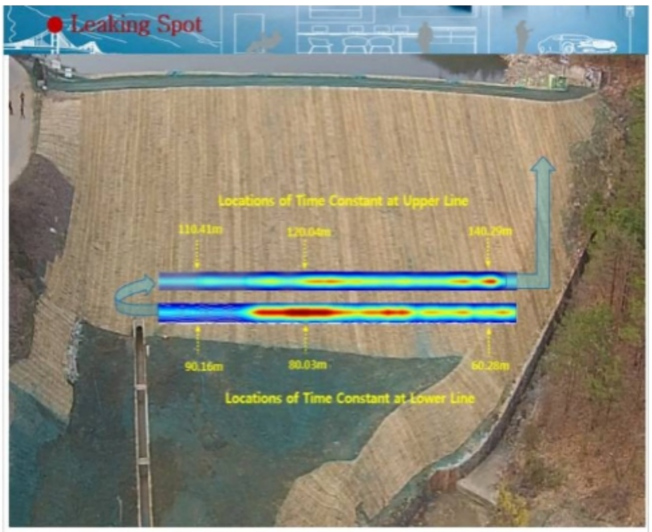

Figure 10:Leaking Spot

The results presented above are based on analysis of variations in daily temperature in all categories. As a result, the setting of detection has a temporal resolution and a spatial resolution of 1 m it is possible to improve the temporal resolution from an intra day analysis (12 h) without significant increase in computing time. The appearance and disappearance of different leakage can be highlighted from an analysis of heating graph.

The method of daily analysis helped to implement easily different variants, chosen according to the characteristics of the instrumented site and goals, as the analysis on hours with sliding windows and a recovery on a few hours. This type of analysis tool proved decisive for issuing early warnings of suspicions of leaks.

Measures of leakage through optical fiber from the GMG with Kumoh National Institute of Technology were in perfect agreement with baseline measures installed in the dam (pore-water pressures) and were considered among the most efficient and most reliable range of auscultation systems tested.

CONCLUSION

The results obtained in this work indicated that fiber-optic temperature measurements are suitable for testing the functioning of earth dam structures and the long-termmonitoring of a dam. This method is particularly suitable for old reservoir to in Yang Pyong, as in the South Korea the varying seasons result in extensive temperature differences between soilstructures and water. The temperature measurements made it possible to monitor water flow inside the soil structures and the thawing of ground frost.

The temperature measurements taken in May with passive method in the old earth dam do not confirm or eliminate the possible risk of dam core erosion due to underground temperature change but they indicate the wet zone clearly. However, it seems more probable and visible with the active method that show a big difference for each zone groundwater temperature well fluctuations are due to periodical changes in permeability, soil properties, rather than due to erosion in the ground.

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Partial Replacement of Cement with GGBS and Metakaolin

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ABSTRACT

Due to exponential growing in urbanization and industrialization, by product from industries is becoming an increasing concern for recycling and waste management. Ground granulated blast furnace slag (GGBS) is by product from blast furnace of iron and steel industries. GGBS is very useful in design and development of high quality cement paste. It effects on strength and durability properties. Concrete occupies unique position among the modern construction materials & is widely used in all types of constructions. It consists of a hard, chemically inert particulate substance. Due to increase in demand of concrete more &more new methods &materials are being developed. This paper presents the use of ground granulated blast furnace slag (GGBS) on strength development of concrete and the use of GGBS and mineral admixture metakaolin. Experimental investigation conducted by complete replacement of slag with cement and partial replacement of slag and mineral admixtures by weight in the form of 3cubes by using M30 grade. Results of GGBS with concrete are compared with the results of partial replacement of GGBS and mineral admixtures. A total of cubes were cast and compressive strength of the concrete specimens were determined at curing age of 3, 7, 28 days. Test results show that strength increases with the increase of slag up to optimum value and also the strength increases by adding of mineral admixture metakaolin. The study of workability of concrete with GGBS as a replacement material with and without adding of mineral admixture.

Key words- Ground granulated blast furnace slag (GGBS), Metakaolin

I. INTRODUCTION

Concrete is typically the most massive individual material element in the built environment. If the embodied energy of concrete can be reduced without decreasing the performance or increasing the cost, significant environmental and economic benefits may be realized. Concrete is primarily comprised of Portland cement, aggregates, and water. Although Portland cement typically comprises only 12% of the concrete mass, it accounts for approximately 93% of the and strength necessary for the design of the structures.

Some of the recent studies in various parts of the world have revealed that Ground granulated blast furnace slag concrete can protect the steel reinforcement more efficiently, so that it can resist corrosion, and thus the structure as a whole. GGBS concrete is a type of concrete in which a part of the cement is replaced by ground granulated blast furnace slag, which is an industrial waste. Thus the implementation of GGBS concrete can minimize corrosion in an effective way. Moreover it can lead to much durable structure without considerable increase in cost.

Ground granulated blast furnace slag from modern thermal power plants generally does not require processing prior to being incorporated into concrete and is therefore considered to be an — environmentally free‖ input material. When used in concrete, ground granulated blast furnace slag is a cementations ‘material that can act as a partial substitution for Portland cement without significantly compromising the compressive strength.

In the present work an attempt has been made to study the suitability of metakaolin as Mineral admixture and its effect on the properties concrete. Metakaolin was blended with cement in various proportions to study the effect of strength on concrete. Concrete mixes were made using Ordinary Portland cement alone as Control and also replacing cement by 10%, 20%, and 30% of metakaolin. The physical properties and compressive strength of concrete were measured.

II. LITERATURE REVIEW

However, wild and khatib reported results on strength development of concrete, where cement was partially replaced with MK (5% to 30%), while sabir el al (2006) carried out the review regarding the use of the claimed clays and metakaolin as Pozzolanas for concretes. Further the compressive tests on the GGBS and MK are not reported so far

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Poon el al (2006) studied the mechanical and durability properties of high performance MK concrete to silica fume concretes found that the performance of MK used in the study was superior to silica fume in terms of strength development.

Al Amoudi et al (1995) and mangat el al (1995) studied the behavior of concrete using supplementary cementing material and found that the incorporation of supplementary cementing materials such as blast furnace slag, fly ash, silica fume as partial replacement of ordinary cement has been found beneficial technique of enhancing the resistance of concrete to sulphate attack.

P. N. Rao et al focused on investigating characteristics of M30 concrete with partial replacement of cement with ground granulated blast furnace slag(GGBS) and sand with ROBO sand(crusher dust). The cubes and cylinders are tested for both compressive and tensile strength. It is found that by the partial replacement of cement with GGBS and sand with ROBO SAND.

III. GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

GGBS is granular material formed when molten iron blast furnace slag is rapidly chilled by immersion of water. It is a granular product with very limited crystal formation, is highly cementations in nature and, ground to cement fines, and hydrates like Portland cement. It has been supplies by Astrra Chemicals in Chennai.

Fig: Ground Granulated Blast Furnace Slag

a) FINENESS OF GGBS:

Weight of the residue left on the sieve is 60grms.Fineness of GGBS is 40%.

b) Standard consistency of GGBS:

S.No	Trail no	% of water added	penetration
1.	Trail-1	0.3%(90ml)	24mm

Physical properties of GGBS are tabulated below:

S.No	Tests	Results
1.	Specific gravity	2.55
2.	Fineness of GGBS	60%
3.	Standard consistency	24mm

IV. METAKAOLIN

Metakaolin (POZZOFILZ) is an SCM that conforms to ASTM C618 and Class N pozzolan specifications. POZZOFILZ HRM is derived from a naturally occurring mineral and is produced under carefully controlled conditions to refine its color, remove inert impurities, and tailor particle size such that much higher degree of purity And pozzolanic reactivity can be obtained. This range improves many properties of concrete while also reducing cement consumption.

Fig: Metakaolin

a) FINENESS OF METAKAOLIN:

Weight of the residue left on the sieve is **80grms.**

Fineness of cement is **20%.**

b) Standard consistency of Metakaolin:

S.No	Trail no	% of water added	penetration
1.	Trail-1	0.3%(90ml)	30mm

Physical properties of MK are tabulated below

S.No	Tests	Results
1.	Specific gravity	2.91
2.	Fineness of GGBS	20%
3.	Standard consistency	30mm

V. EXPERIMENTAL PROGRAMME

A) MIX DESIGN:

The method mix design proposed by IS was first employed to design conventional concrete mixes and finally GGBS and MK are partially replaced to obtain concrete mixes.

B) Mix design for M30-Grade Concrete:

STIPULATIONS FOR PROPORTIONING

a) Grade designation : M30

b) Type of cement : OPC 53 grade conforming to IS 8112

c) Maximum nominal size of aggregate 20mm

d) Minimum cement content : 320 kg/m3

e) Maximum water-cement ratio : 0.45

f) Workability : 100mm (slump)

g) Exposure condition : severe (for reinforced concrete)

h) Degree of supervision : good

i) Type of aggregate : crushed angular aggregate

j) Maximum cement content : 450kg/m3

k) Chemical admixture type : super plasticizer conplast

C) SIEVE ANALYSIS:

(1) Coarse aggregate : 20mm passed 10mm retained.

(2) Fine aggregate : conforming to zone II of table of IS 10262:2009

0.42 : 1 : 2.14 : 3.48

VI. PREPARATION OF TESTING SPECIMEN

A) CASTING OF THE SPECIMENS:

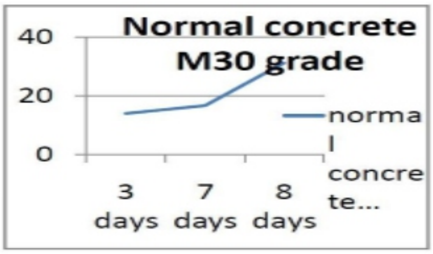
The present experimental work includes casting and testing of specimens to know the compressive strength of cubes. These concrete cubes are casted and tested as per IS 516-1959 specifications.

The specimens are casted for the following:

1. M30 grade concrete.
2. M30 grade concrete with OPC (800gms) + 10% GGBS (100grms) +10% MK (100grms)
3. M30 grade concrete with OPC (600gms) + 20% GGBS (200grms) + 20% MK (200grms)
4. M30 grade concrete with OPC (400gms) + 30% GGBS (300grms) + 30% MK (300grms)

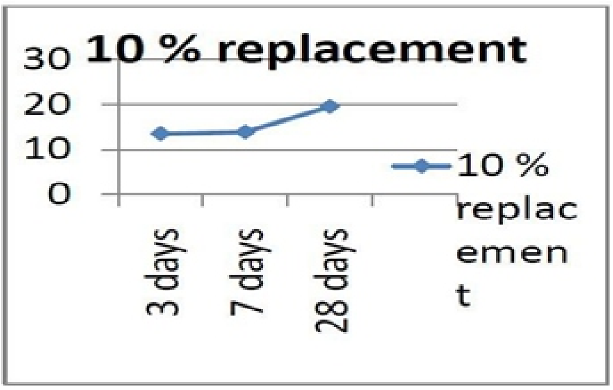
VII. COMPRESSIVE STRENGTH (M30):

A) COMPRESSIVE STRENGTH OF NORMAL CONCRETE



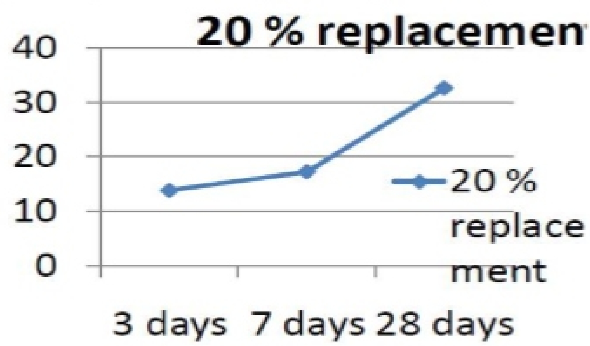
B) Compressive strengths for 10% replacement of GGBS and K

S.NO	Mix proportions	3 days In (MPa)	7days In (MPa)	28 days In (MPa)
1	1: 2.15: 3.63	12	15.5	28
		14.2	15.5	33.33
	Average	13.5	15.5	30.67



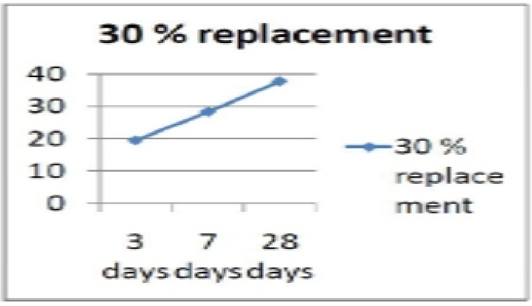
C) Compressive strengths for 20% replacement with GGBS and MK

S.No	Mix proportions	3 days In (MPa)	7days In (MPa)	28 days In (MPa)
1	1: 2.15: 3.63	13.3	16.88	32
2		14	17.77	33.33
	Average	13.87	17.32	32.66



D) Compressive strengths for 30% replacement with GGBS and MK

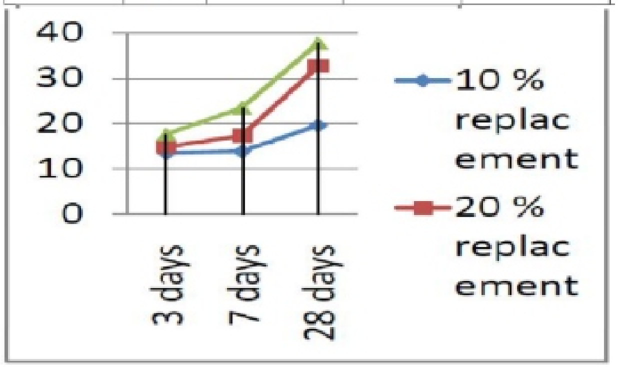
S.NO	Mix proportions	3 days In (MPa)	7days In (MPa)	28 days In (MPa)
1	1: 2.14: 3.48	20	26.66	36
		19.11	30	39.55
	average	19.55	28.33	37.77



E) Comparison for all replacements:

Curing days	Normal concrete	10% replacement	20% replacement	30% replacement
3 days	30	13.5	13.87	19.55
7 days	32.44	15.5	17.32	28.33
28 days	31.22	30.67	32.66	37.77

1.



CONCLUSIONS

From the results tabulated in the earlier chapter the following statements can be derived:

1. From the designed mix proportions of M30 grade of concrete the desired characteristic compressive strengths for cubes are achieved in conventional concrete, GGBS and MK.
2. The strengths achieved in concrete made with percentage use of GGBS and MK achieved high strengths when compared with cement.
3. Super plasticizer named is used to attain workability and water cement ratio.
4. At 28 days curing, the 30% replacement of cement with GGBS and MK gave very high strength.
5. From the above experimental results, it is proved that GGBS can be used as an alternative material for cement, reducing cement consumption and reducing the cost of construction. Use of industrial waste products saves the environment and conserves natural resource

SCOPE AND OBJECTIVES OF PRESENT STUDY

The aim of this research is to evaluate the compressive strengths of concrete by GGBS and MK as an alternative to the use of Ordinary Portland Cement (OPC) in the production of concrete. The individual objectives will include:

1. Alternative materials other than GGBS and MK such as fly ash, copper slag, and silica fume can be used for replacement.

2. Metakaolin has a great potential in concrete as cement replacement at lower cost as compared to traditionally used super pozzolan.

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Concrete Overlay as A Possible Solution to Damaged Concrete Pavement at the Durban Container Terminal

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ABSTRACT

Concrete overlays for concrete pavement have not been used locally, but there is extensive experience of the method abroad and particularly in the USA, where concrete as a paving material in port terminals, airports and highways remains popular. Asphalt overlays have been used more extensively locally, and recently in the Gauteng Freeway improvement programme, where both unreinforced, jointed and continuously reinforced, un-jointed pavements have been overlaid. For container terminals, asphalt overlays are not an option because of the high loading applied, particularly in the container stacks. The method proposed for the Durban Container Terminal (DCT) is therefore for a reinforced concrete overlay. Alternatives using steel or polypropylene fibres have been investigated but have not been pursued because of cost and other considerations. Given that the bulk of the terminal paving is intact, and severely stressed areas either have been, or are programmed to be repaired, the construction of an overlay is an option as construction time is minimized, resulting in reduced terminal disruption, the remaining capacity of the existing pavement is utilized, construction cost is lower than reconstruction and this option is more environmentally acceptable.

Index terms: Concrete overlays, Paving, Construction of an overlay, Damaged concrete pavement.

I. INTRODUCTION

The need has never been greater for engineered strategies to preserve and maintain the nation's pavements. With shrinking budgets, ever-increasing traffic volumes and loads, and the critical emerging focus on infrastructure sustainability and pavement preservation, highway agencies are being asked to do more with less in managing their pavement networks (Concrete Overlays, 2011). Concrete overlays can serve as sustainable and cost-effective solutions for improved management of pavement assets, including preservation, resurfacing, and rehabilitation. In addition, they contribute to more sustainable construction practices by preserving and extending pavement service for years beyond the original design life. Many concrete overlays have been in service for decades, effectively extending the life of the original pavement structures for 30 years or more (Guide to concrete overlays, 2014). For successful overlaying of an existing pavement, the pavement must be free of major structural defects. Where existing slabs have failed completely or exhibit active cracks, these must be rectified before overlaying. Passive cracks, which represent the majority of cracks in the DCT terminal, do not need to be repaired.

Figure 1: Typical concrete overlay (before [left] and after concrete overlay placement [right])

II. OVERLAY ALTERNATIVES

Concrete overlays may be of the bonded or un- bonded type. The structural differences are substantial and are graphically illustrated in fig 2.

- Bonded overlays are constructed so as to be monolithic with the underlying slab, thereby strengthening the existing pavement. For successful application, full adhesion must be achieved and the existing concrete slabs must be essentially free from defects. The purpose of bonded concrete overlays is to add structural capacity and eliminate surface distresses on existing pavements that are in good to fair structural condition. Bonded overlays generally provide resurfacing solutions for routine or preventive pavement maintenance and for minor rehabilitation. The key to achieving desired performance is to ensure the two structures, the existing pavement and the overlay, behave as one structure (Guide to concrete overlays, 2014).
- An un-bonded overlay is separated from the existing pavement by a suitable separation layer. As there is no monolithic action with the existing slab, a thicker slab is required than in the case of a bonded overlay as illustrated in fig 2. Un-bonded overlays are however more tolerant of defects in the existing slab and prevent reflective cracking. The purpose of an un-bonded overlay is to restore structural capacity to an existing pavement that is moderately to significantly deteriorated. Un-bonded overlays are minor or major rehabilitation strategies. The term "un-bonded" simply means that bonding between the overlay and the underlying pavement is not needed to achieve the desired performance (i.e., the thickness design procedure does not consider the existing pavement as a structural component of the surfacing layer). Thus, the overlay performs as a new pavement, and the existing pavement provides a stable base. The indicated solution for DCT is therefore un-bonded overlay.

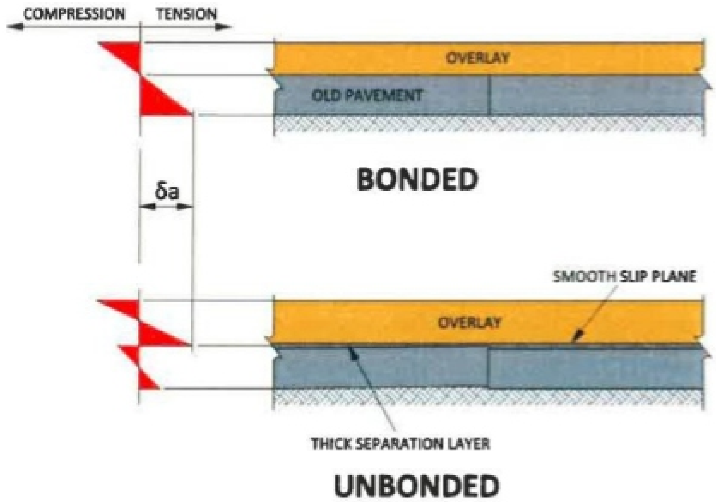

Figure 2: Structural difference between Bonded and Un- bonded overlays

III. STRUCTURAL OVERLAY RECOMMENDATION

With reference to the performance of overlays the most appropriate overlay for DCT is an un-bonded concrete overlay. The use of an un-jointed (in the longitudinal direction) continuously reinforced concrete overlay increases the tolerance of the overlay to defects in the existing slab, obviates the need for transverse joints in the paving, and can be more quickly constructed if the required paving equipment is available. A comparison of the construction costs for reconstructing the pavement or overlaying the existing pavement indicates a significant cost saving for overlaying (Annexure A). The estimates are based on the assumption that the concrete rubble can be used as backfill to the gravity wall structure. Should this not be possible, for whatever reason, dumping costs could add significantly to the cost of reconstruction, and create an environmental problem.

The cost of reconstructing the pavement is seen to be substantially higher than the cost of overlaying by approximately 50% (Table 1). Overlaying the existing pavement is accordingly adopted in preference to reconstruction in considering the various operation options.

Construction time and operational disruption are also minimized. The use of a continuously reinforced, slip formed reinforced concrete overlay is accordingly recommended solution for continued use of straddle carriers (SC), particularly for the heavier 1/3 machines. Overlaying is also an option for Rubber Tyred Gantry (RTG) operation. A slightly thicker overlay is required for the 5 high stacking associated with RTG operation. The marginal cost of increasing the overlay thickness is however minimal.

The recommended separation layer, dictated by the condition of the existing slabs, is for a 25mm asphalt layer. Apart from performing the debonding function, this separation layer facilitates the accommodation of moderate faulting, surface spalling and joint spalling in the existing slab without having to repair these defects.

The thickness of the overlay, which is dictated by the condition of the existing pavement and the thickness of the monolithic pavement required for the design load on the existing support, is calculated at 300mm for 5 high stacking. This is based on the assumption that major defects in the existing slab will be rectified before overlaying. The thickness of the required overlay slab is based on the Pier 1 slab design which was designed for the loading which is assumed to be appropriate for Pier 2 i.e. either 1/3 straddle operation or RTG operation with 5-high stacking. Slab reinforcement is designed on the basis of crack control. As it is desirable to limit crack spacing and crack width for the purpose of minimizing moisture ingress and shear transfer in the slab, the reinforcing content is selected accordingly.

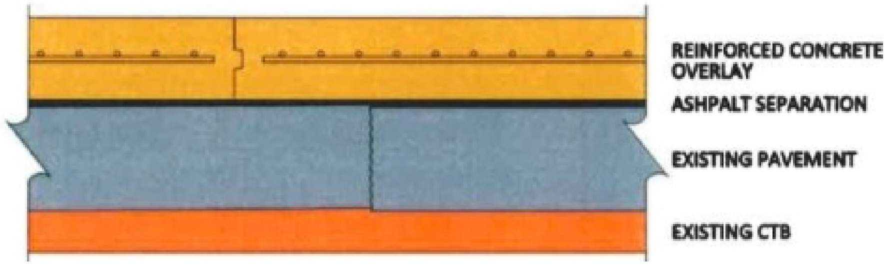

Figure 3: Concrete overlay of existing pavement

IV. DRAINAGE

The existing terminal is drained by way of slot drains running the length of the terminal at intervals of approximately 30m. The average drain length is approximately 1000m. As there are approximately 7 drains, the total length of the slot drains in the terminal is of the order of 7km in berth 108-109 terminal. The drains comprise of a precast top which incorporates the drainage slot, supported on a precast concrete base slab 2m wide as shown if Fig 4. As the buttresses across the slots are inadequate to resist compressive forces arising from slab expansion, expansion joints are provided on either side of the drain as shown.

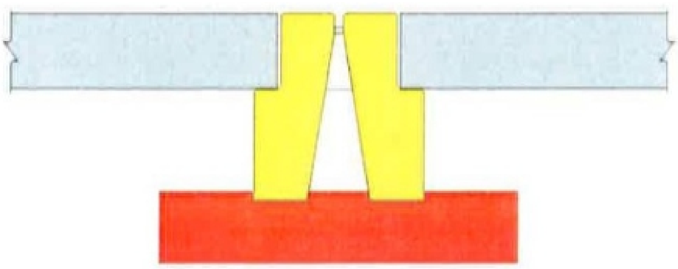

Figure 4: Profile of Original Slot Drain

As a result of the flat soffit and the fact that there is no longitudinal gradient on the drains, flow rates in the drains are insufficient to carry sand to the catch- pits for removal. Consequently many of the drains have become silted up and dysfunctional. Some of the pavement failure is attributed to saturation of the sub grade as a result of blocked drains. Another problem with these drains is there susceptibility to spalling. Although efforts to unblock the drain have been made, the difficulties are reported to have resulted in abandonment of cleaning efforts, and many of the drains remain blocked.

CONCLUSIONS AND RECOMMENDATIONS

Concrete overlays can serve as sustainable and cost- effective solutions for improved management of pavement assets, including preservation, resurfacing, and rehabilitation. In addition, they contribute to more sustainable construction practices by preserving and extending pavement service for years beyond the original design life.

I would recommend that the un-bonded overlay option be implemented based on the above research as opposed to reconstruction

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Bivariate Flood Frequency Analysis of Sungai LUI Catchment in Malaysia using Archimedean Copulas

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A B S T R A C T

In order to formulate mitigating measures against flood damages, flood frequency analyses are required. There are several methods of flood frequency analyses applied throughout the world. This study will focus on bivariate flood frequency analyses. Archimedean copulas have been adopted, using Gumbel, Frank and Clayton copulas. Sungai Lui catchment in Malaysia was adopted as the study area. Akaike Information Criterion (AIC) was used to assess the copulas. L-moment was used to assess the distributions. Graphical methods were used to find relationships between Flood Peak, Flood Volume and Flood Duration. Results show that Generalised Extreme Value (GEV) was the best fitted distribution for Flood Peak, and Weibul were the best fitted distribution for Flood Volume and Flood Duration. Gumbel was found to be the best copulas with minimum AIC values. Relationships were established between Flood Peak-Flood Volume, Flood Peak-Flood Duration and Flood Volume-Flood Duration.

Index Terms- Akaike Information Criterion, Clayton Copula, Flood frequency analysis, Frank Copula, Gumbel Copula, Joint Cumulative Distribution, Marginal Distribution Parameter.

I. INTRODUCTION

Floods are disasters that have taken many lives, damaged properties and the environment. Floods are common events occurring throughout the world. In Malaysia, there are 189 river systems, of which 89 are in Peninsular Malaysia, 78 are in Sabah and 22 are in Sarawak. All river systems discharge immediately to the sea [1]. There are several types of flood in Malaysia, including: rainstorm flood, city-based flash flood, debris flow and mud flow, landslide, tidal flood, dam release, and bund failure [2]. However, Smith [3] classified floods into two main categories: river floods and coastal floods, to differentiate the effects of tidal for coastal and no tidal effects for river.

In order to reduce fatalities and damages, mitigation measures are required. Flood frequency analyses are often required to estimate the peak flows and frequencies, which will enable mitigation measures to be formulated. Flood frequency analyses are commonly applied in many countries including: Malaysia [2,4], United Kingdom [5], United States [6], Australia [7], New Zealand [8], Canada [9] and Italy [10].

Several approaches have been used in flood frequency analyses. The univariate flood frequency analysis is widely used in hydrological studies. Often only flood peak or flood volume is statistically analyzed. There were also studies where more variables or multivariate flood frequency analyses have been used [11,12,13,14]. In this study however, the focus will be on bivariate flood frequency analyses.

Several methods can be used to perform multivariate flood frequency analyses [15]. One of the methods was to use copulas [16,17,18]. Copula can be defined a multivariate probability distribution for which the not important probability of each variable is uniform [19]. It was used to describe the dependence between random variables and popular variables in high-dimensional statistical applications. Copulas enable one to easily model and calculate the distribution of random vectors by estimating not important and copula separately [20].

Copulas are used to determine the dependence between random variables [21]. The Sklar's theorem [19] states that, the joint behaviour of a random variable (X, Y) with continuous marginal u = Fxy(X) = P (X ≤ x) and v = FY (Y) = P (Y ≤ y) can be expressed by its associated dependence function or copula C.

For two (2) dimensional case, for all (u, v) Є [0,1]2the relationship can be formulated as below:

$$F_{x,y}(X,Y) = C[F_x(X), F_y(Y)] = C(u,v) \qquad (1)$$

$F_{x,y}(x,y)$ is joint cumulative distribution function (CDF) of random variables X and Y.

Archimedean copulas admit a clear formula and known as a class of copulas [18]. Archimedean copulas are popular because they allow modelling dependence in randomly high dimensions with only one limit/guideline, governing the strength of addiction [22]. Examples of copulas are Clayton, Gumbel and Frank Copula, which will be used in this study. Table 1 shows summary of the Bivariate Archimedean copulas with their corresponding generator.

Table 1: The Bivariate Archimedean Copulas with their corresponding generator

Name	Bivariate copula $C_\theta(u,v)$	Generator $\varphi_\theta(t)$	Parameter θ
Clayton	$(\max[u+v-1;0])^{-\frac{1}{\theta}}$	$\frac{1}{\theta}(t^{-\theta}-1)$	$\theta \in [-1,\infty) \setminus \{0\}$
Gumbel	$\exp(-((-\log(u))^{\theta}+(-\log(v))^{\theta})$	$(-\log(t))^{\theta}$	$\theta \epsilon [1,\infty)$
Frank	$-\frac{1}{\theta}\log(1+\frac{(\exp(-\theta u)-1)(\exp(-\theta v)-}{\exp(-\theta)-1}$	$-\log\left(\frac{\exp(-\theta t)-}{\exp(-\theta t)-}\right.$	$\theta \epsilon R \setminus \{0\}$

The not important distribution is probability explanation and static is the probability distribution of the variables contained in the subset. It presented the probabilities of different values of the variables in the subset without reference to the values to other variables. Basically term not important distribution is applied to those variables in the subset of variables being held. It also refers to the process of removing the influence of one or more event form probability [23]. For example if X and Y are separate random variables and f (x,y) is the value of their joint probability distribution at (x,y), the function will be given as:

$$g(x) = f(x) = \sum_y (f(x,y) and\ h(y) \sum_x f(x,y) \quad (2)$$

In this study, the objective is to perform bivariate flood frequency analyses using Archimedean copula. Data from Sungai Lui catchment in Malaysia will be used to assess the approach.

II. MATERIALS AND METHODS

Sungai Lui catchment is subjected to anthropogenic manipulations in hydrological status. Some landforms resulting from urban growth and agricultural activities were not caught in the land use and topography maps. This omission included most of the pool, which can affect the sedimentation process via an increase in deposition rate [24]. Sungai Lui catchment comprises steep slopes, and is exposed to high intensity rain. Sungai Lui catchment is located 300 07' – 300 12' N, and 10100 52' – 10100 58' E on the upstream of the Langat River with a drainage area of 68.25 km2 and a basin length of 11.5 km as shown Figure 1. The lower limit and maximum heights of the basin are 61 m and 1207 m, respectively, while the average altitude is approximately 354 m above the sea level. Figure 2 shows Sungai Lui catchment is steep with an average slope 35%. Approximately 60% of the catchment areas have a gradient that is higher than 30%. Sungai Lui (river) hydrometer station is situated at the outlet of Sungai Lui catchment with an average annual water discharge of 55.05 x 106 m3 and an average annual sediment load of 5.88 x 103 tonnes. The average annual precipitation at Kg. Sungai Lui rain gauge station is approximately 2188.3 mm. In terms of land utilization, Sungai Lui catchment comprises 80.35% forest, 9.85% rubber and 2.6% orchards. The remaining part of this catchment area consists of mixed horticulture and crops, urban areas, and mining land. Three (3) characteristic of floods: flood peak, flood volume and flood duration will be used in this study. Bivariate joint distributions of the flood characteristics will be derived using the concept of copula considering a lot of parameters and nonparametric marginal distribution for these three characteristics. A set of parametric distribution functions, and nonparametric methods based on density estimation and orthonormal series will be used to determine these three characteristics. In conventional methods of flood frequency analysis, the marginal distribution functions of peak flow, mass and duration are assumed to conform to some specific parametric distribution function. Each parameter was evaluated by using L-moment method

[25,10]. The concept of copula relaxes the restriction of the traditional flood frequency analysis by selecting marginal from different families of probability distribution functions. Akaike Information Criterion (AIC) [26] and graphical method will be applied in determination of copula model and joint distribution between flood variables. In this study, the Archimedean copula has been adopted. AIC is a measure of the relative quality of statistical model for a given set of data [26]. AIC deals with two (2) models: a trade-off between the goodness of fit of the model and complexity of the model. Basically AIC does not provide testing a null hypothesis as it can say nothing about the quality of the model in an absolute sense. For any statistical model, the AIC value is:

$$AIC = 2k - 1\ln(L) \quad (3)$$

where, k is the number of parameters in the model L is the maximized value of the likelihood /parameters of statistical model. L-moment standardised are called L-moment ratios and it is a sequence of statistics used to summarise the shape of a probability distribution [25]. L-moments are analogous to standardized moments which compute sample statistics of individual data at the site, defining distribution parameters and the suitability of the probability distribution.

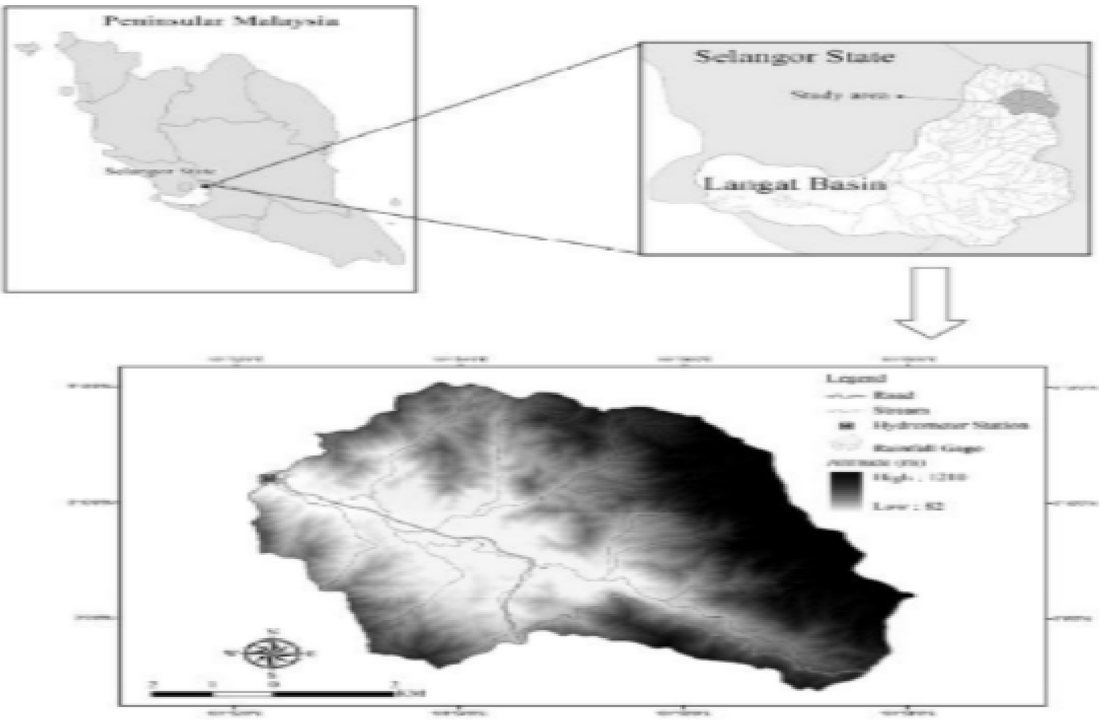

Figure 1: Geographic location of Sungai Lui catchment

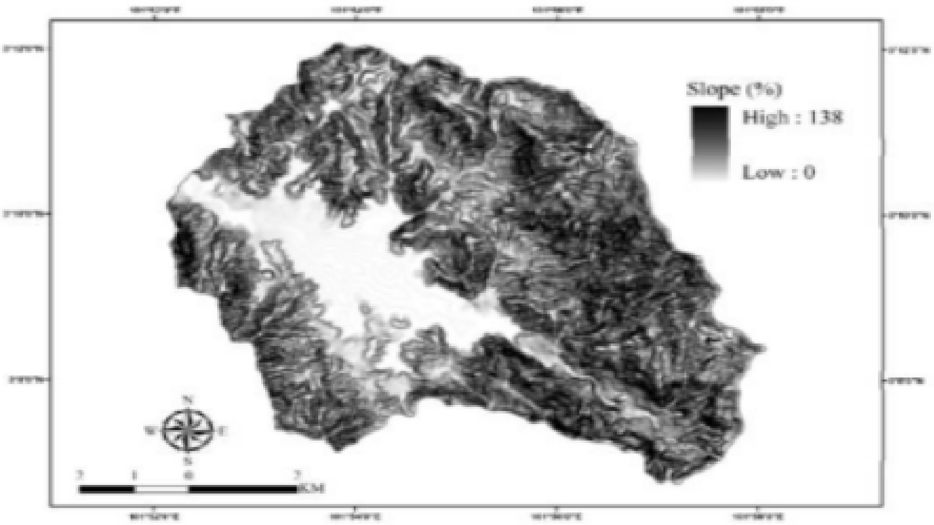

Figure 2: Slope map of Sungai Lui catchment

III. RESULTS AND DISCUSSIONS

The joint cumulative distribution function of peak flow and duration, peak flow and volume and duration and volume are illustrated in Figures 3, 5 and 7, respectively. The contour lines of joint distribution of each pairs of flood characteristics are illustrated in separate Figures 4, 6 and 8, respectively.

The contour lines of joint cumulative distribution of peak flow and duration as indicated in Figure 3 described for each cumulative distribution (CUV) contour. There is an opposite relationship between peak flow and duration. If flood peak is high, the flood duration will be low and vice versa. With higher cumulative distribution centres, it allows higher peak flow and flood duration. In Figure 4, the joint probability graph presented the scenes of two conditions with peak flow and flood duration occurring at the same time with the combination distribution contours interval at 0.2, 0.4, 0.6, 0.8 and 1.0 in X and Y axis.

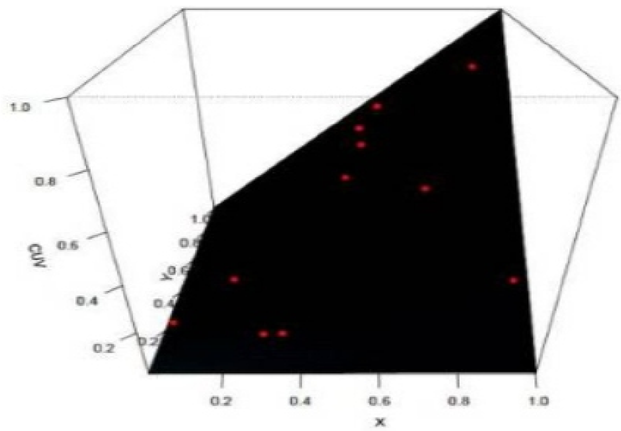

Figure 3: Joint cumulative distribution function of peak flow and duration

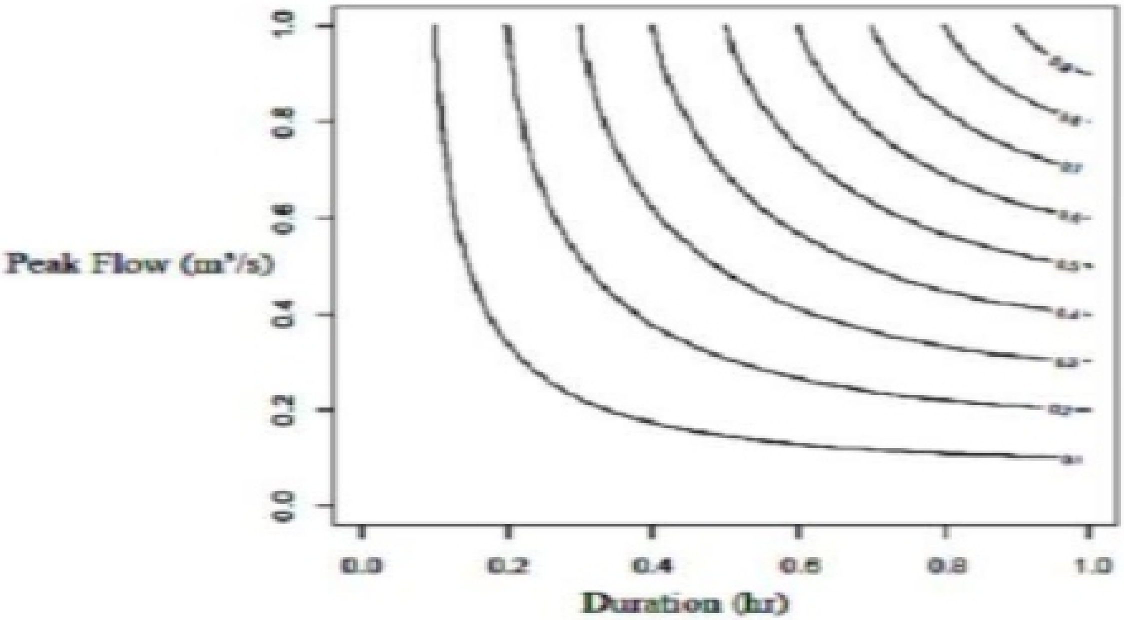

Figure 4: Contours showing two-dimensional view of joint cumulative distribution function of peak flow and duration

Contours lines of joint distribution of peak flow and volume are presented in Figure 5. The flood characteristics are often important for flood volume based on cumulative distribution (CUV). Figure 6 shows the flood volume observation and prediction of daily flows for all years are close to each other based on the flood volume. Madiero et al. [27] found that linear relationship exists between standardised peaks and volumes in homogeneous regions.

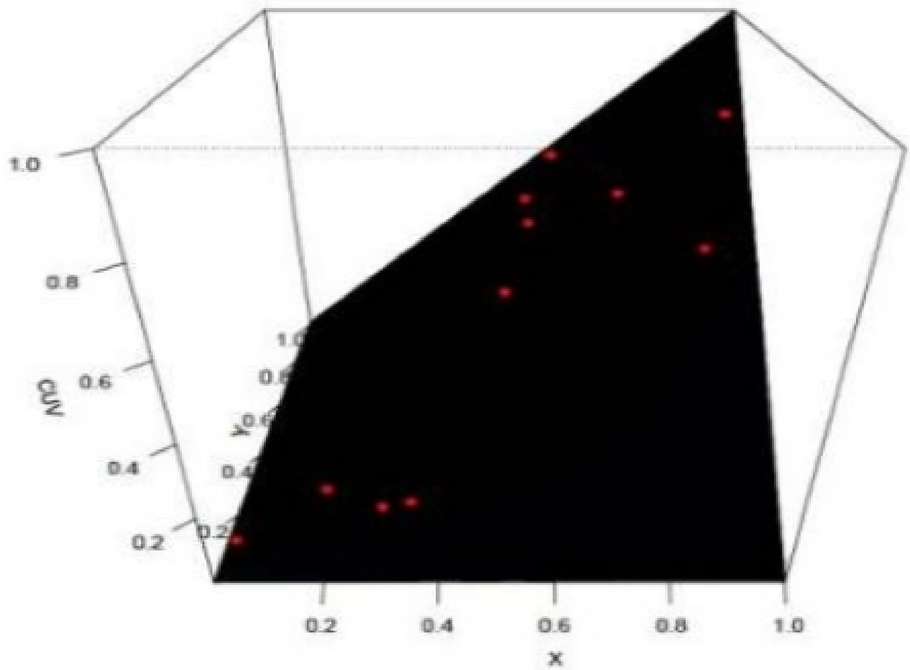

Figure 5: The joint cumulative distribution function of peak flow and flood volume

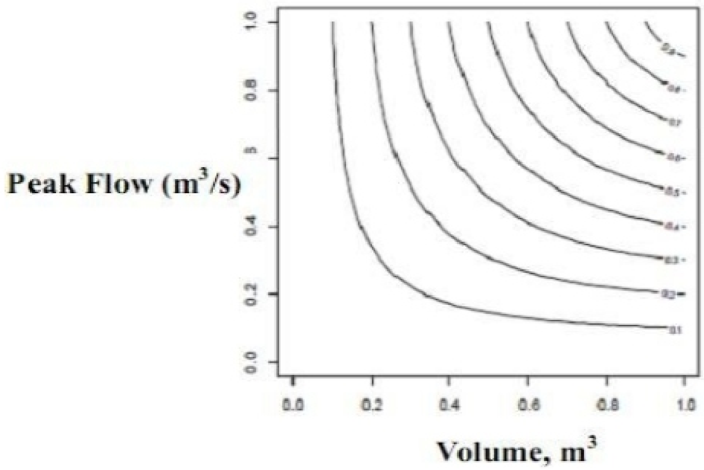

Figure 6: Contours showing the two-dimensional view of joint cumulative distribution function of peak flow and volume.

Figure 7 shows positive correlations between flood volume and duration. Figure 8 illustrates the chance of two flood characteristic with peak duration and flood volume occurring at the same time which also indicates positive correlation between volume and duration.

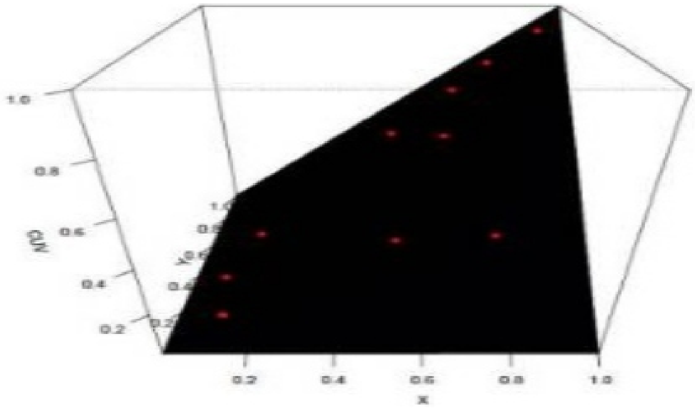

Figure 7: Joint cumulative distribution function of flood volume and flood duration

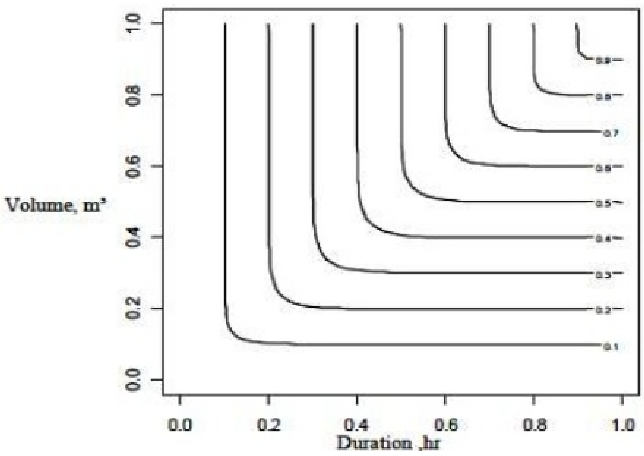

Figure 8: Contours showing the two-dimensional view of joint cumulative

Table 2 presents the parameter for α, β and γ based on L-Moment method and Table 3 is the summary of value τ, θ and AIC. The best value of α, β and γ from Table 2 is the best fitted distribution was Generalised Extreme Value (GEV) from peak flow flood variable. This was consistent with the findings of Salarpour et al. [28] where GEV is the best marginal distribution fit for peak flow. No to and La Loggia [10] also found GEV to be the most robust distributions. However, for flood duration and flood volume, Weibull was found to be the best fitted distribution.

Table 2: Parameter of marginal distribution by using method of L-Moment

Flood Variable	Best Fitted Distribution	Parameter
Peak Flow	Gev. Extreme Value (GEV)	$\alpha = 0.4421$ $\beta = 66.243$ $\gamma = 141.462$
Duration	Weibull	$\alpha = 0.2762$ $\beta = 76.88$ $\gamma = 135.65$
Volume	Weibull	$\alpha = 0.8842$ $\beta = 86.542$ $\gamma = 168.99$

Flood Variable Best Fitted Distribution Parameter

Peak Flow

Gev. Extreme Value (GEV) $\alpha = 0.4421$

$\beta = 66.243$

$\gamma = 141.462$

Duration

Weibull $\alpha = 0.2762$

$\beta = 76.88$

$\gamma = 135.65$

Volume

Weibull $\alpha = 0.8842$

$\beta = 86.542$

$\gamma = 168.99$

In Table 3, the best copula for flood frequency was Gumbel compared to Clayton and Frank copula because of the AIC value. Zhang and Singh [29] stated that the best model of copula is when the AIC value was at minimum value. All the parameters for τ and θ were based on dependence structure into a single number and the τ was measured using Kendall's tau approach. Similar methods were used by Reddy and Ganguli [18] but they found Frank copula to be more suitable for their sets of data.

Table 3: Estimation of τ, θ, and AIC value for Clayton, Gumbel and Frank Copula

	Flow-Duration			Flow-Volume			Volume-Duration		
	Clayton	Gumbel	Frank	Clayton	Gumbel	Frank	Clayton	Gumbel	Frank
τ	0.0909091	0.0909091	0.0909091	0.5636364	0.5636364	0.5636364	0.3454545	0.3454545	0.3454545
θ	1.10	1.204721	1.829922	2.291667	1.507343	1.347723	1.527778	5.982673	3.336723
AIC	-2.84201	*-2.19223*	-3.55621	-58.72132	*-42.66982*	-86.16722	-345.16782	*-189.44721*	-567.23567

Copulas provide a convenient way to model and test related variables. Several copulas with different builds are Flow-Duration Flow-Volume Volume-Duration Clayton Gumbel Frank Clayton Gumbel Frank Clayton Gumbel Frank

τ 0.0909091 0.0909091 0.0909091 0.5636364

0.5636364 0.5636364 0.3454545 0.3454545

0.3454545

θ 1.10 1.204721 1.829922 2.291667 1.507343

1.347723 1.527778 5.982673 3.336723

AIC -2.84201 -2.19223 -3.55621 -58.72132

-42.66982 -86.16722 -345.16782 -189.44721

-567.23567

available for modelling these relationships. Shape differences among copulas can be seen with the descriptive functions. These can be used both in fitting copulas to date and in applying informed judgment to select a copula for a given application. This study focused on Bivariate Copulas but many of the estimates can be extrapolated to the multivariate cases. The result accomplished from this study was by using Archimedean copula, which was useful to estimate peak flow, flood volume, flood duration and the joint distribution functions of flood characteristics.

CONCLUSION

Bivariate flood frequency analyses of Sungai Lui catchment has been satisfactory using Archimedean copulas. Assessment using AIC has found Gumbel copula to be the most satisfactory. Assessment using L-moment has found that GEV was the best fitted distribution for Flood Peak, whilst Weibull was the best fitted distribution for Flood Volume and Flood Duration. Relationships were also established between flood peak-flood volume, flood peak-flood duration and flood volume-flood duration. In conclusion, copulas can be used in flood frequency analyses to assist water managers in flood prediction and formulating appropriate mitigating measures.

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Vulnerability Assessment of Soft Ground Storied Building of Different Shape of Regular and Plan Irregular Buildings under Earthquake Load

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ABSTRACT

Open ground storey (OGS) building has taken its place in the Indian urban environment due to the fact that it provides much needed parking facility in the ground storey of the building. Surveys of buildings failed in past earthquakes show that this types of buildings are found to be one of the most vulnerable. In this paper all buildings are considered located in seismic zone V for the study using CSI SAP2000 v18 software. Infill stiffness was modeled using a diagonal strut approach. In present study Seismic vulnerability assessment of seven OGS building models have same plan area of different shapes by non-linear static analysis. Base shear, roof displacement and inter storey drift compare with the storey level regular and different shape of plan irregular buildings.

Keywords - Open ground storey, Non-linear static analysis, Equivalent diagonal strut.

I. INTRODUCTION

As per Indian standard IS 1893 (Part 1) : 2002, soft storey is the one in which the lateral stiffness is less than 70% of that in the storey above or less than 80% of the average lateral stiffness of the three storeys above. Often, open ground storey buildings are called soft-storey buildings, even though their ground storey may be soft and weak. Generally, the soft or weak storey usually exists at the ground storey level, but it could be at any other storey level. Behavior of soft storey building to seismic forces has to be critically examined considering various geometrical and seismic parameters. The energy developed during the seismic load is dissipated by the vertical resistant elements of the floor on the ground which results in the appearance of plastic deformations which transforms the ground floor in a mechanism, wherein the collapse is inevitable. In this paper all buildings are considered located in seismic zone V for the study using CSI SAP2000 v18 software. Infill stiffness was modeled using a diagonal eccentric strut approach. In present study Seismic vulnerability assessment of seven OGS building models have same plan area of different shapes by non-linear static analysis. Base shear, roof displacement and inter storey drift compare with the storey level regular and different shape of plan irregular buildings. The displacement control nonlinear static pushover analysis is carried out for all 7 models. they are subjected to a target displacement of 1.4m in the X-direction at the roof level i.e. 4 % drift is consider.

II. MODELLING

Seven G+9 open ground reinforced concrete buildings are modelled using CSI SAP2000 v18 software –

a. '+' shaped building (Model 1)

b. 'E' shaped building (Model 2)

c. 'I' shaped building (Model 3)

d. 'L' shaped building (Model 4)

e. 'T' shaped building (Model 5)

f. 'U' shaped building (Model 6)

g. Square shaped regular building (Model 7)

In this paper, all the models have plan area of 400m2 and each panel is of 5m×5m dimension. The individual storey heights for each models are 3.5m. The total structural height is 35m. The models are fixed at the base.

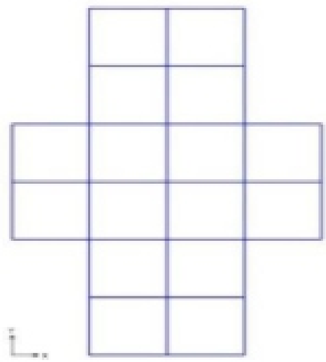

Fig 1: Plan of the Model 1

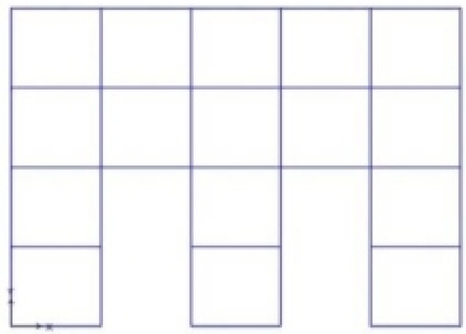

Fig 2: Plan of the Model 2

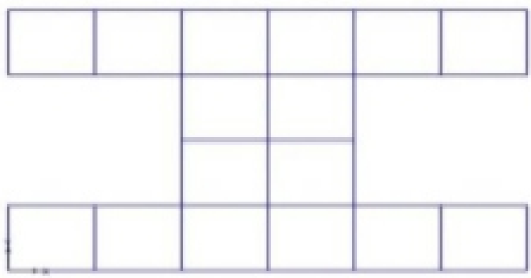

Fig 3: Plan of the Model 3

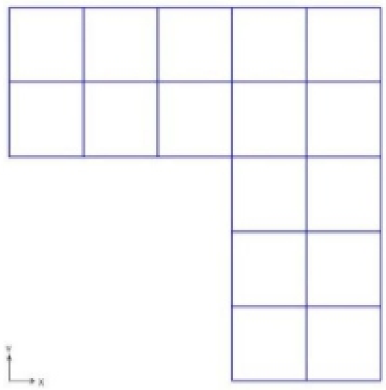

Fig 4: Plan of the Model 4

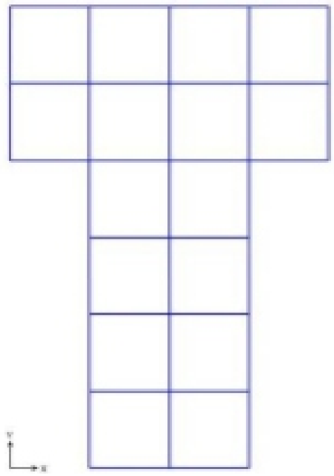

Fig 5: Plan of the Model 5

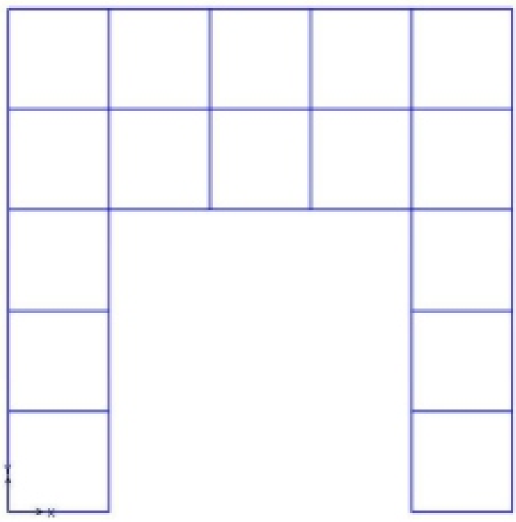

Fig 6: Plan of the Model 6

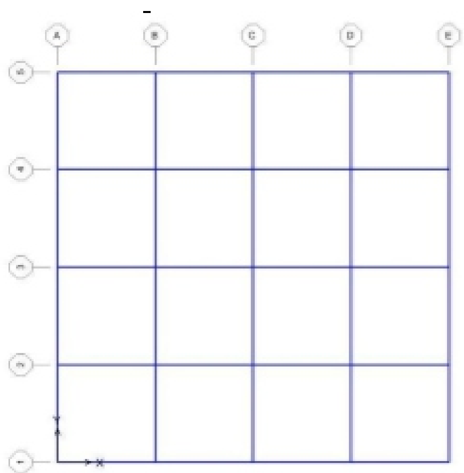

Fig 7: Plan of the Model 7

2.1. Materials Used

Concrete grade: M30

Reinforcement grade: Fe415

Masonry:

Modulus of elasticity (E) = 20 GPa Poisson's Ratio = 0.213

Thermal Expansion = 5*10-6

Weight = 20KN/m2

2.2. Details of Structural Elements

Size of beams = 400mm × 400mm

Size of columns = 600mm × 450mm

Thickness of slab = 150mm

Thickness of infill walls = 125mm

Width of equivalent strut = 1.53m

Thickness of equivalent strut = 125mm

Percentage of steel = 1.83%

2.3. Design of Equivalent Concentric Strut

Masonry infill walls when subjected to lateral loading behave like diagonal struts. In the present study, infill walls are designed as equivalent concentric struts as proposed by K. H. Abdelkareem et Al (2013). In this section the procedure to calculate the dimensions of the equivalent strut is discussed[5].

$$w=0.25d_{inf}\ ,\ t = t_{inf}$$

where,

w = Width of the equivalent concentric strut

d_{inf} = Diagonal length of the in fill wall

t = thickness of the equivalent strut

t_{inf} = thickness of the in fill wall

2.4.Inter storey drift

Lateral drift and inter storey drift are commonly used damage parameter in structural analysis. Inter storey drift can be calculated by [7].

$SD_i = (U_i - U_{i-1}) / hi$

Where, $(U_i - U_{i-1})$ = relative displacement between successive storey,

h_i = storey height.

III. RESULTS AND DISCUSSIONS

3.1. Pushover curve

Pushover curve for the building represent the global behavior of the frame with stiffness and ductility. The variations of the Base Shear with respect to the Roof Displacements i.e. Pushover Curves for the models are compared in Fig. 8. Plastic hinges are developed in columns of ground level soft storey.

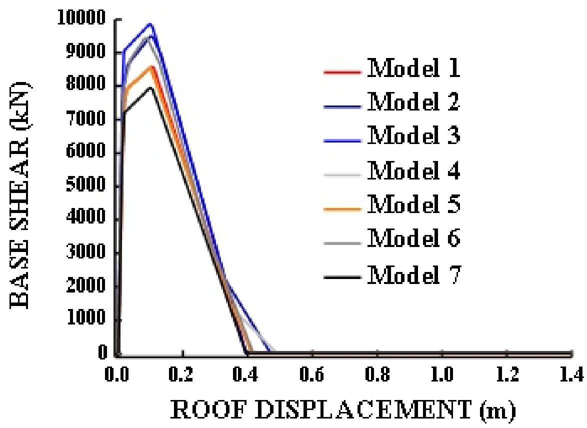

Fig 8: pushover curve

3.2. Displacement variation

The variations of displacement of buildings at storey level are shown in table 1. It is observed that displacement of ground storey is high then very little amount of Displacement increase after increase the storey level or increase the height of the building for regular and different shape of irregular building.

Table 1: Displacement variation in each storey

Storey level	Displacement (m)						
	+	E	I	L	T	U	REGULAR
1	0.0913	0.0916	0.0905	0.091	0.0914	0.074	0.0899
2	0.0925	0.0926	0.0915	0.092	0.0925	0.075	0.091
3	0.0933	0.0932	0.0921	0.0927	0.0932	0.0756	0.0916
4	0.0943	0.0939	0.0928	0.0934	0.094	0.0763	0.0925
5	0.0953	0.0946	0.0934	0.0942	0.0948	0.077	0.0934
6	0.0964	0.0954	0.094	0.095	0.0956	0.0777	0.0942
7	0.0974	0.0961	0.0946	0.0957	0.0964	0.0784	0.0951
8	0.0984	0.0967	0.0952	0.0964	0.0972	0.0791	0.0959
9	0.0994	0.0974	0.0958	0.0972	0.0979	0.0798	0.0967
10	0.1005	0.0981	0.0964	0.0979	0.0987	0.0804	0.0975

3.3 Inter storey drift (ISD)

The variations of inter storey drift of buildings at storey level are shown in Table 2. From this table, it is observed almost all the inter storey drift occurs at open ground storey for all type of regular and irregular buildings. Inter storey drift is very less from second storey to roof of the buildings.

Table 2: ISD variation in each storey

STOREY LEVEL	Inter storey drift (mm)						
	PLUS	E	I	L	T	U	REGULAR
1	26.086	26.171	25.857	26	26.114	21.143	25.686
2	0.343	0.286	0.286	0.286	0.314	0.286	0.314
3	0.229	0.171	0.171	0.2	0.2	0.171	0.171
4	0.286	0.2	0.2	0.2	0.229	0.2	0.257
5	0.286	0.2	0.171	0.229	0.229	0.2	0.257
6	0.314	0.229	0.171	0.229	0.229	0.2	0.229
7	0.286	0.2	0.171	0.2	0.229	0.2	0.257
8	0.286	0.171	0.171	0.2	0.229	0.2	0.229
9	0.286	0.2	0.171	0.229	0.2	0.2	0.229
10	0.314	0.2	0.171	0.2	0.229	0.171	0.229

3.4 Performance point

The performance points of the models are shown in Table 3.Performance point has been shown for regular and different shape of irregular buildings after 70mm to 72 mm displacement and base shear variation from 7720.939 Kn to 9514.828 kN.

Table 3: Performance Points of the Models

Model No.	Base Shear (kN)	Roof Disp. (m)
Model 1 (+)	8323.507	0.072
Model 2 (E)	9234.239	0.072
Model 3 (I)	9514.828	0.063
Model 4 (L)	8353.897	0.074
Model 5 (T)	8320.356	0.072
Model 6 (U)	9353.419	0.074
Model 7 (REGULAR)	7720.939	0.07

CONCLUSION

From present analysis model in SAP2000 it can be concluded that, this study highlights the poor seismic performance of a building with soft ground storey.

Maximum yielding occurs at the soft storey, because of soft stories maximum plastic hinges are forming though the base force is increasing.

Increasing the storey levels storey displacement increase and almost all the inter storey drift occurs at open ground storey for all type of buildings.

Performance point has been shown for regular and different shape of irregular buildings after 70mm to 72 mm displacement and base shear variation from 7720.939 Kn to 9514.828 kN.

Plastic hinges are developed in columns of ground level soft storey which is not acceptable criteria for safe design.

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