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# Journal Of Civil Engineering And Technology Research

**Aims and Scope**

Journal of Civil Engineering and Technology Research intended to bring together the information in different areas of civil engineering around the world. The aim of this journal is to combine theory and practice in civil engineering and thus advancement of civil engineering sciences. It will provide a platform for academicians, researches and engineers to share their experience and solution to problems in different areas of civil engineering.

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## Contents

# Optimization Of Piano Key Weir For Dam

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## ABSTRACT

*Non gated spillways are most suitable for small of medium catchment area and for large catchment area gated spillway is more suitable. For safety and cost reason, the fully gated spillway will be avoided in near future and non gated spillway will be accepted solution. Non gated spillway is hydraulically more effective and safe in operation. The discharge capacity of spillway is directly propositional to the crest length. Many types of weirs have been developed with the purpose to increase the crest length. Among these types the recently developed, Piano key weirs prove to be more advantageous regarding hydraulic performance compare to ogee weirs. Moreover its small foundation width makes the Piano key weir cost effective solution to increase the discharge capacity. Still today only initiatory design procedure is available which cannot be generalized.*

***KEYWORD:Piano key weir, Ogee weir, Spillway.***

## 1. INTRODUCTION

The Piano key weir concept was recently developed by Blanc of the University of Briska (Algeria) and Lemperiere (Hydrocoop) in Franch. (Lemperiere and Ouamane, 2003). Similar to Labyrinth weir, Piano key weir crest is folded in plan to increase discharge, however it has a smaller foundation width compare to labyrinth weir, due to overhanging on both side.

The typical Piano Key weir has folded rectangular crest layout (in plan) with sloping inlet and outlet key floor that are cantilever on both side of the spillway foundation width. Figure.1 shows a typical Piano Key weir geometry.

## 2. EXPERIMENTAL DATA FOR PIANO KEY WEIR:

The experiments have been carried out on 1:35 scale model of basic Piano key Weir geometry shown in Figure.1 for optimization. For this purpose four various Piano Key weir models were selected and tested in 0.85 m. wide and 1.5 m. deep flume at various discharge. The hydraulic data for piano key weir model shown in Figure: 2.

## 3. TESTING PROCEDURE:

First of all, model was set in flume and leak test was carried out to check all joints were water tight. The model result was collected for discharge ranging from 8.41 m3/s/m. to 69.30 m3/s/m. Discharge were measured by using the calibreted rectangular SWF. Water level had been maintained to stabilise for a minimum five minute. To varify that stable flow condition had been achived, then readings were taken at various chainage on upstream and down stream weir. A spread sheet was used to calculate the total head and weir discharge co-efficient (Cd) at various flow rate.

## 4. RESULT ANALYSIS AND DISCUSS:

Table no: 1 show the Geometric parameters of various studied piano key weir models. Experimental Results tabulated in table no: 2 and prepared graphs Figure: 4 show the Relationship between Discharge vs. Cd and Figure: 5 show the Relationship between Discharge vs. Head.

## 5. CONCLUSION:

In this study Piano Key Weir optimization investigation have focused on effect of outlet key, inlet key ratio. With increasing discharge, interference of nappe in outlet key also increase which result in decrease discharge capacity. The ratio of bo/ai affects the performance of Piano key weir. The width of outlet key increase, its ability to collect all of the flow from the inlet key increase and discharge it downstream with minimum local submergence condition. Submergence effect in outlet key reduces the discharge capacity of weir. At high discharge, the performance of upstream apex dropdown due to local submergence at upstream side of outlet key. The ratio of discharge co-efficient curve was plotted with various discharges. The data in Table 2 show that bo/ai = 1.35, geometry is the most efficient of the 4 geometry tested.

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**Table 1. Geometrical Characteristics of the studied PK Weir (alldimensionsareincm.)**

| Model No. | L/B | bo/ai | P | Pm | ai | bo | w | B | S in. | S out. | t |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PK1 M1 | 3.42 | 1 | 13.1 | 8.75 | 13.3 | 13.3 | 35 | 85 | 0.5 | 0.5 | 0.8 |
| PK2 M1 | 3.42 | 1.2 | 13.1 | 8.75 | 12.1 | 14.6 | 35 | 85 | 0.5 | 0.5 | 0.8 |
| PK2 M2 | 3.42 | 1.35 | 13.1 | 8.75 | 11.4 | 15.3 | 35 | 85 | 0.5 | 0.5 | 0.8 |
| PK2 M3 | 3.42 | 1.45 | 13.1 | 8.75 | 10.9 | 15.9 | 35 | 85 | 0.5 | 0.5 | 0.8 |

**Table 2. Cd at 50 m. Chainage (U/S)**

| Discharge in cu.m./s /m | Ogee Weir | | PK1 M1 (1:1) | | PK2 M1 (1:20) | | PK2 M2 (1:35) | | PK2 M3 (1:45) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | H | Cd | H | Cd | H | Cd | H | Cd | H | Cd |
| | L/B =1.00 | | L/B =3.42 | | L/B =3.42 | | L/B =3.42 | | L/B =3.42 | |
| 8.41 | 3.36 | 0.46 | 1.54 | 1.49 | 1.44 | 1.649 | 1.47 | 1.6 | 1.3 | 1.922 |
| 21.01 | 5.04 | 0.63 | 3.63 | 1.03 | 2.94 | 1.412 | 2.77 | 1.54 | 3.01 | 1.363 |
| 33.62 | 6.76 | 0.65 | 4.96 | 1.03 | 4.76 | 1.097 | 4.66 | 1.13 | 4.76 | 1.097 |
| 46.23 | 8.19 | 0.67 | 6.36 | 0.98 | 6.23 | 1.007 | 6.27 | 1 | 6.33 | 0.983 |
| 58.54 | 9.59 | 0.67 | 7.83 | 0.91 | 7.42 | 0.981 | 7.46 | 0.97 | 7.49 | 0.967 |
| 69.3 | 10.88 | 0.65 | 8.38 | 0.97 | 8.47 | 0.952 | 8.4 | 0.96 | 8.68 | 0.918 |

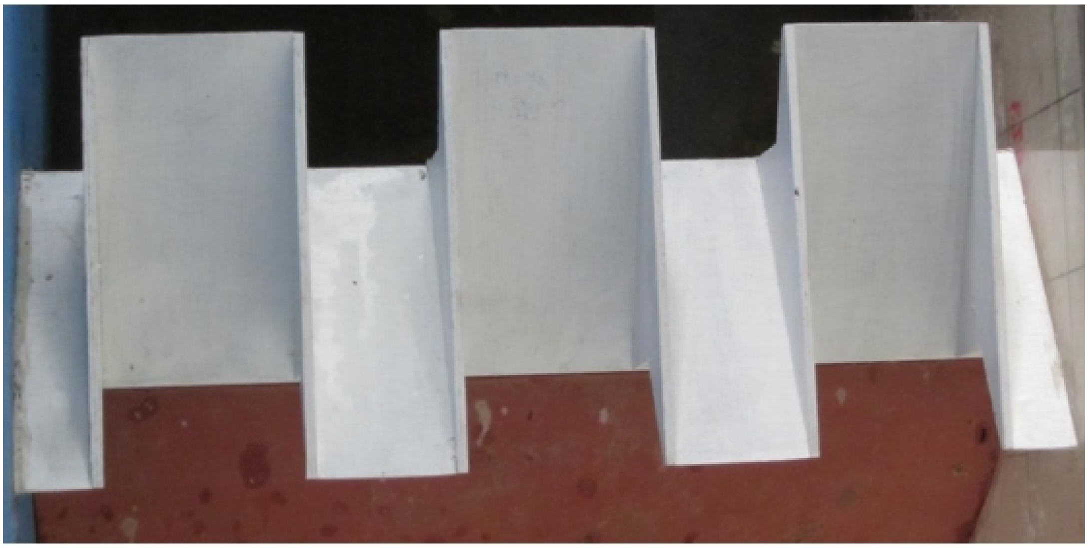

**Figure 1. PK2 M3 weir Model**

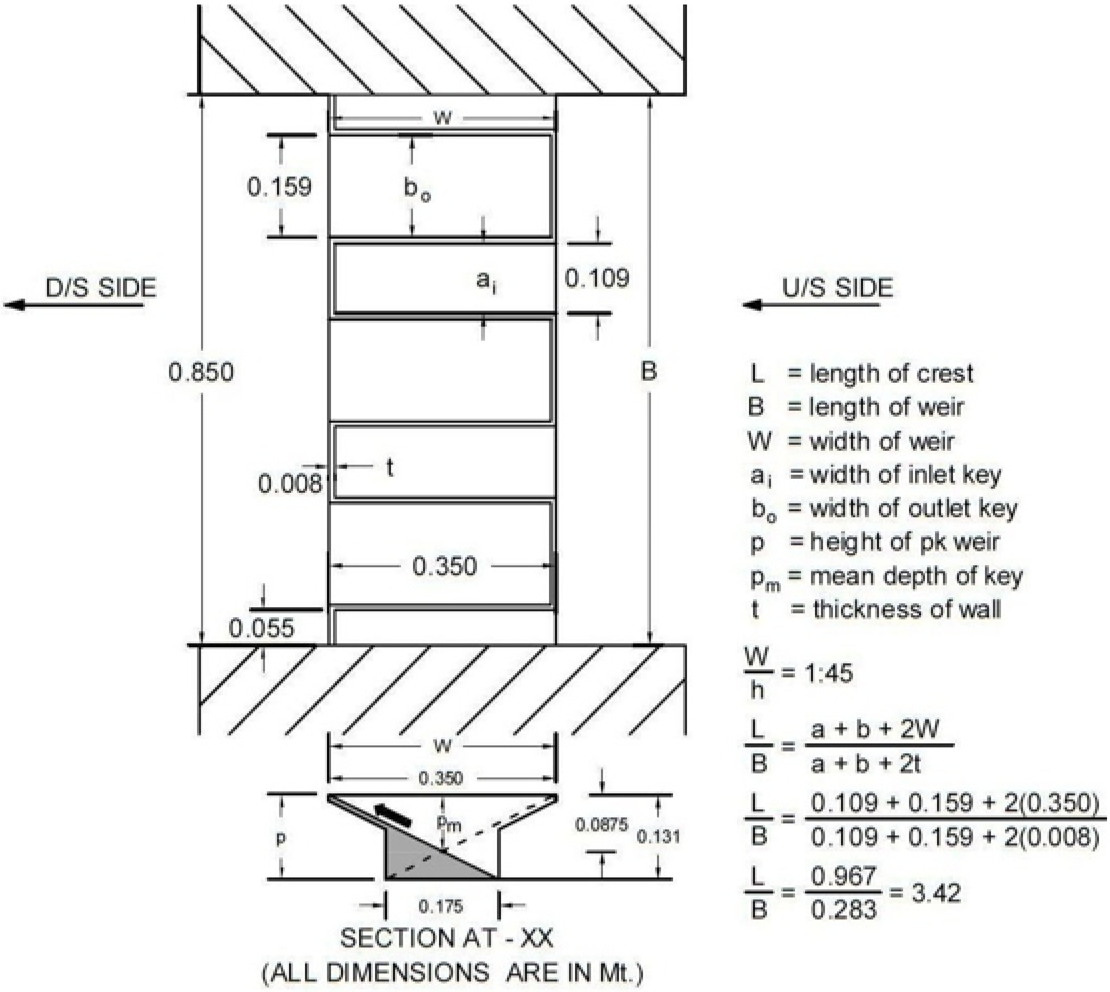


**Figure 2. PK2 M3 Model Detail**

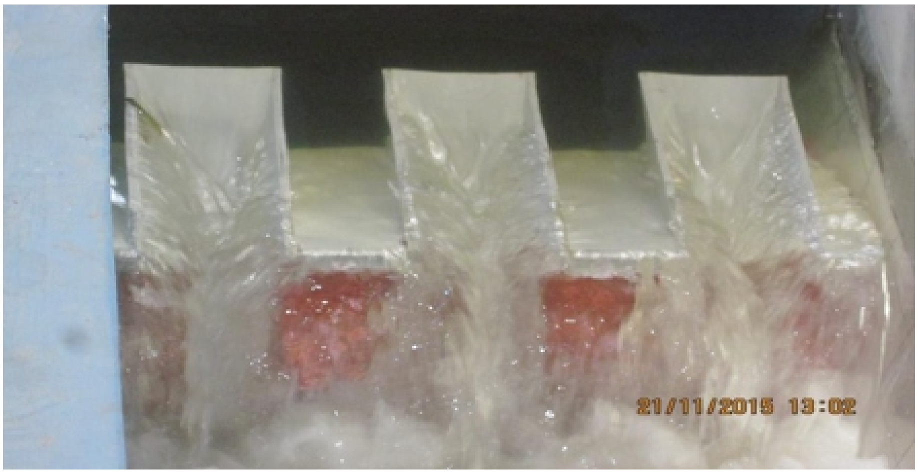


**Figure 3. PK2 M3 Model Photo**

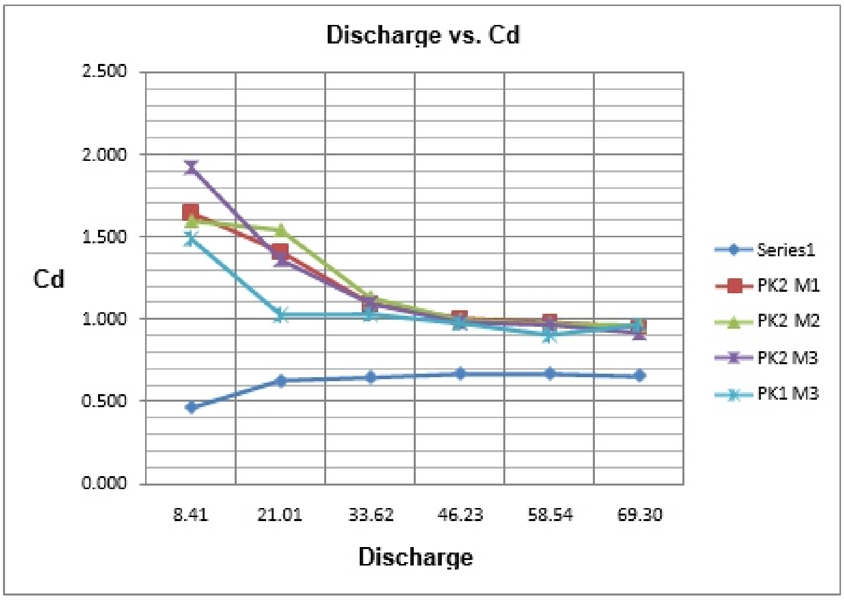


**Figure 4. Discharge vs. Cd**

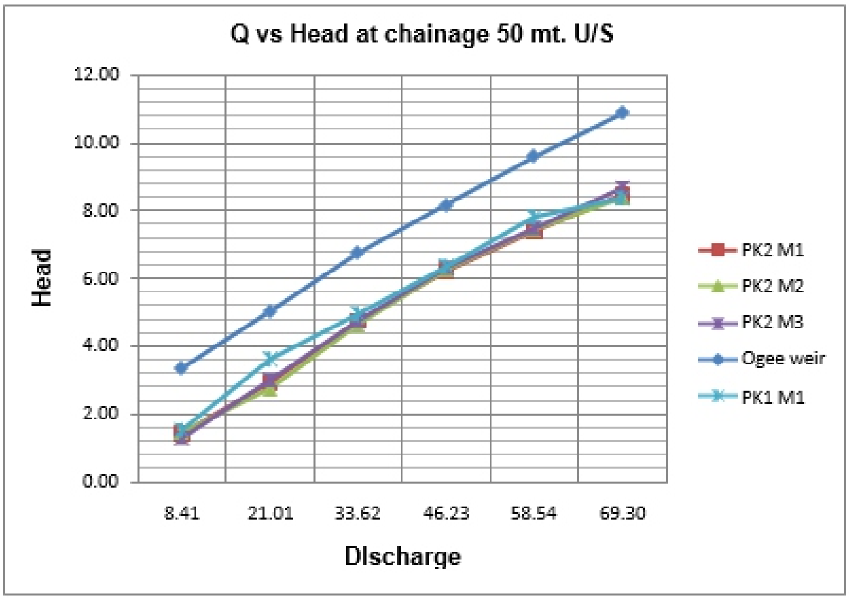


**Figure 5. Discharge vs. Head at Chainage 50 mt. U/S**

# Expermental Study On Ferro- Geopolymer Wall Panel

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## A B S T R A C T

*Rural development has assumed global attention especially among the developing nations. It has great significance for a country like India where majority of the population, around 65% of the people, live in rural areas and were shortage in housing stock. All these needs lead to affordable shelters with access to developed land, appropriate building material and technology. One of the environmental friendly building material technologies for cost effective housing is ferrocement wall panel. Ferrocement wall panel is used by BMTPC (Building Materials & Technology Promotion Council) to achieve a low cost building construction effectively.*

*Precast wall panels were casted using ferro cement and ferro-geopolymer to study its effectiveness. Skeleton steel cage and chicken mesh of are to be provided. The geopolymer mix constitutes flyash instead of cement, M- sand and an alkaline solution comprising sodium hydroxide and sodium silicate solution. Cast the specimens using the mortar and reinforcement and conduct the load deflection tests on them. Conduct a comparative study in terms of strength and cost, so as to prove that, it is a cost effective material for rural housing constructions. Hence obtain a most viable & cost effective housing component. Hope that my work can lead towards a comprehensive and integrated approach for promotion and transfer of potential and cost effective, environmental friendly technologies including locally available material for sustainable development on housing.*

***Key words: ferrocement, ferro geopolymer, precast wall panel, wire mesh, sustainable development***

## 1. INTRODUCTION

Rural development has assumed global attention especially among the developing nations. It has great significance for a country like India where majority of the population, around 65% of the people, live in rural areas. The present strategy of rural development in India mainly focuses on poverty alleviation, better livelihood opportunities, provision of basic amenities and infrastructure facilities through innovative programmes of wage and self-employment. So many scientific and technological interventions in the field of rural life have been well discussed and documented by certain research institutions and organizations. BMTPC (Building Materials & Technology Promotion Council), is one such institution under Ministry of Urban Employment & Poverty Alleviation, Government of India strives to promote innovative, cost-effective building materials and products through evaluation, validation of proven technologies, demonstration and large scale dissemination of information. Their vision is to provide solutions to all the special focus on the common man in the area of sustainable materials, appropriate construction technologies and disaster resistant construction. The IAY (Indira Awaas Yojana) is such a core program for providing free housing to families in rural areas. The massive housing concept as a part this scheme is achieved by the introduction of precast building components which were validated and approved by BMTPC. Ferrocement wall panel is one such cost effective building component which was widely and effectively used in the rural areas of Tripura.

Ferrocement is a relatively new material consisting of wire meshes and cement mortar. It consists of closely spaced wire meshes which are impregnated with rich cement mortar mix. While the mortar provides the mass, the wire mesh imparts tensile strength and ductility to the material. The ferrocement possess high resistance against cracking, high fatigue resistance, higher toughness and higher impermeability. It possess unique qualities of strength and serviceability. It can be constructed with a minimum of skilled labor and utilizes readily available materials. Proven suitable for boatbuilding, it has many other tested or potential applications in agriculture, industry, and housing. It can be constructed with a minimum of skilled labor and utilizes readily available materials. There are several applications of Ferro cement which include building industry, irrigation sector, water supply and sanitation areas.

Studies indicate that it appears to be an excellent composite in the case of seismic resistant structures.

The main difference between ferrocement and reinforced concrete is ferrocement is a thin composite made of cement matrix reinforced with closely spaced small diameter wire meshes instead of larger diameter rods and large size aggregates. The thickness of ferrocement generally ranges from 25 - 50 mm. The latest ACI Code encourages the use of non - metallic reinforcement and fibres. The following definition was adopted by the ACI Committee: "Ferrocement is a type of thin wall reinforced concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials."

Ferrocement is an environment friendly sound technology and possesses excellent unique properties such as good tensile strength, improved toughness, water tightness, liglitness, fire resistance, resistance to cracking and cost, time and material effective construction technology. Inorder to further make the reduction in the cost of massive housing in rural areas, an alternative can be introduced in the place of cement. Thereby we can reduce the evolution of tons of carbon dioxide into atmosphere by making use of flyash. Hence on the other scenario, huge level deposition of flyash on low lying areas can be controlled to a certain extent. In this context I"m introducing a new material ferro geopolymer cements in place of normal ferrocements.

## II. LITERATURE SURVEY

### [1] Mohamad Mahmood Civil Engineering department Mosul University Iraq

The paper describes the results of testing folded and flat ferrocement panels reinforced with different number of wire mesh layers. The main objective of these experimental tests is to study the effect of using different numbers of wire mesh layers on the flexural strength of folded and flat ferrocement panels and to compare the effect of varying the number of wire mesh layers on the ductility and the ultimate strength of these types of ferrocement structure. Seven ferrocement elements were constructed and tested each having (600x380mm) horizontal projection and 20mm thick, consisting of four flat panels and three folded panels. The used number of wire mesh layers is one, two and three layers. The experimental results show that flexural strength of the folded panels increased by 37% and 90% for panels having 2 and 3 wire mesh layers respectively, compared with that having single layer, while for flat panel the increase in flexural strength compared with panel of plan mortar is 4.5%, 65% and 68% for panels having 1, 2 and 3 wire mesh layers respectively. The strength capacity of the folded panels, having the particular geometry used in the present study, is in the order of 3.5 to 5 times that of the corresponding flat panels having the same number of wire mesh layers.

### [2] Dr.T.S.Thandavamoorty and S.Durairaj Professor at Adhiparasakti Engineering college Melmaaruvathur

A hollow cored ferrocement floor panel of size 900 mm X 600 mm was precast with cement mortar 1:2 and cured for 7 days. Then it was arranged in a loading frame and tested under gradually increasing static loading till failure. The ultimate load sustained by the panel was 85 kN. Experimental Program A welded mesh was prepared with two layers of chicken mesh. The specimen was casted with cement mortar 1:2 and reinforcement mesh as prescribed. The finished specimen was cured for 7 days. The specimen was arranged on a loading frame. Load was applied in increment and dial reading for each in increment was recorded. Load was increased till failure of the panel. Results The ultimate load observed was 85 kN. This load was distributed on the panel with the intensity of 78.7 kN/m2. As per IS 875 part 2 the live load recommended on floor is only 2 kN/m2. Going by this consideration ferrocement floor panel is suitable, realistic and feasible.

## III. OBJECTIVE OF THE WORK

The objective is to experimentally study the behaviour of ferrocement and ferro geopolymer wall panel so as to get a viable and cost effective component for massive housing construction at rural areas.

## IV. METHODOLOGY

The methodology of the work consist of

1) Selection of a stiff mix.
2) Casting panel specimens of normal ferrocement and geopolymer cement.
3) Conduct loading tests and the cost requirement studies
4) Study their effects under loading and documentation

## V. MATERIAL TEST

**TABLE 1: MATERIAL TESTING RESULTS**

| Tests | Material | Equipment Used |
|---|---|---|
| Specific Gravity | Ramco cement (OPC 43 grade) | Le Chatelier flask |
| Specific Gravity | Fine Aggregates | pycnometer |
| Water absorption | Fine Aggregates | Vessel |

## VI. EXPERIMENTAL INVESTIGATION

### A. EXPERIMENTAL PROGRAM

The test program consists of casting and testing the panels with normal ferrocement and with geopolymer cements. The sections that are designed and validated by BMTPC are directly followed in my work. And further details are based on the IS 456-2000 code. The panel having a standard dimension (900x720x30) was followed. Actually the panel have a „C‟ shaped cross section with a flange arising all around. This shape is adopted by them to get a high moment of inertia and inorder to place them properly and to be bolted. The minimum reinforcement was provided as per IS 456-2000. It includes GI wires straightened  to form a skeleton form work along with a wire mesh. Both of them constitute the whole reinforcement cage for the panel. Spacing is also as per the specifications provided by the code. Wire mesh of hexagonal shape is used with 22 gauge and 12mm hexagonal opening. The cross section is appeared to be „C" shaped as shown in Figure 1.

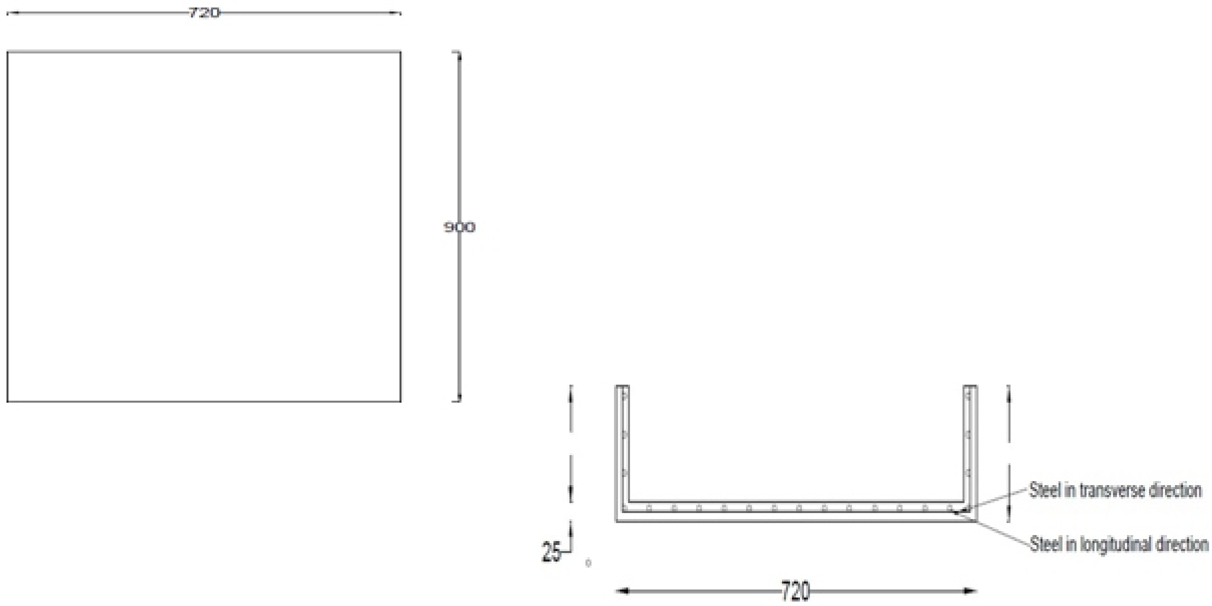


**Figure.1 Plan and cross section of the panel**

In case of ferrocement wall panel, cement is used to cast the panel along with GI wires and wire mesh as in Figure.2 below.

**Figure.2 Reinforcement cage with GI wire and wire mesh**

**Figure.3 Casting of panelsFigure.**

But in case of ferro geopolymer wall panels cement is fully replaced with fylash and it constitute geopolymer. The medium for this geopolymer is an alkaline solution chemically combined of sodium hydroxide and sodium silicate. So the ferro-geopolymer constitute flyash, sand and alkaline solution. Sodium hydroxide is having a concentration of 16M and sodium silicate solution helps in the dissolution of ions in alkaline liquid which promote the polymerisation process. This polymerisation took place in different conditions such as in ambient condition, under oven dry condition and under the presence of steam. So curing should be under these conditions. No water curing is required for this type of mortar mixes. Normal ferro cement wall panel is casted as in the Figure.3 below and cured for 28 days and ferro-geopolymer panels for ambient curing.

**4 Experimental set up of wall panel**

### A. TEST PROCEDURE

The strength of the specimens were tested using a 100t loading frame; LVDT was used to determine the deflection at the center of the panel. The panel is loaded at it base thickness only and the flange portion is devoided from it. The strength of the panel is found by uniformly distributed loading using the jack attached to the loading frame as in Figure.4. The behaviour of panel is keenly observed from beginning to the failure. The loading was stopped when the panel was just on the verge of collapse. The crack propagation and its development and propagation are observed keenly. The values of load applied and deflection are noted directly and further the plot of load vs. deflection is performed which is taken as the output. The load in KN is applied with uniformly increasing the value of the load and the deflection under the different applied loads is noted down. The applied load increased up to the breaking point or till the failure of the material.

The behaviour of this panel is somewhat like the buckling of a slender member like column. Care should be taken whether the load is uniformly distributed to the 3cm thickness only and no load is get applied to the flange portion, as there may be a chance of bending this portion initially. Note the behaviour of panel carefully and note the load at which the panel fails finally.

## VII. EXPERIMENTAL RESULTS AND DISCUSSION

### A. LOAD CARRYING CAPACITY

Ultimate strength of panels under loading was confirmed through recording the maximum load indicated by LVDT, but the cracking load was specified with developing the first crack on the specimen. It was found that the load carrying capacity of all ferro geopolymer panels are found to be better than the normal ones.

### B. CRACK PATTERN

At Initial stages of loading, all were un-cracked. When the applied load reached to the rupture strength, the specimens, started to crack. The failure pattern in all the tested specimens was observed as a buckling failure.

### C. LOAD VS. DEFLECTION GRAPH

As the load increases the deflection of the panel begins. Load will be directly proportional to deflection. The load values and corresponding deflection of normal ferrocement and ferro geopolymer upto a safe load of 700kN are noted and are given in the below Figure.5 and Figure.6. As per the test result it is observed that geopolymer wall panels show less deflection than control beam at the safe load.

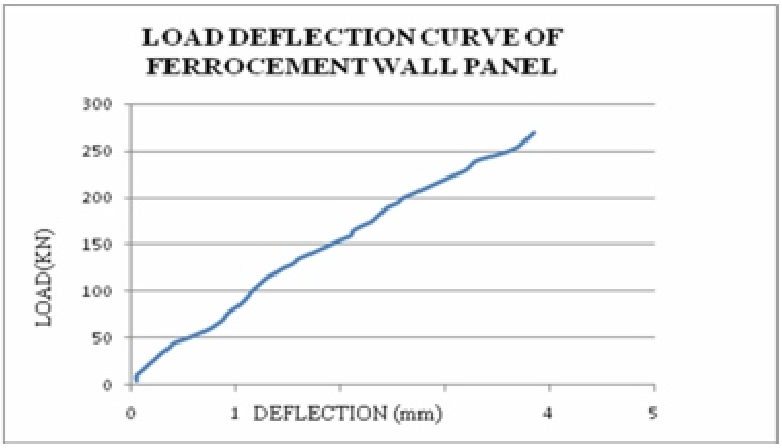


**Figure.5 Load Vs. Deflection graph for ferrocement wall panel**

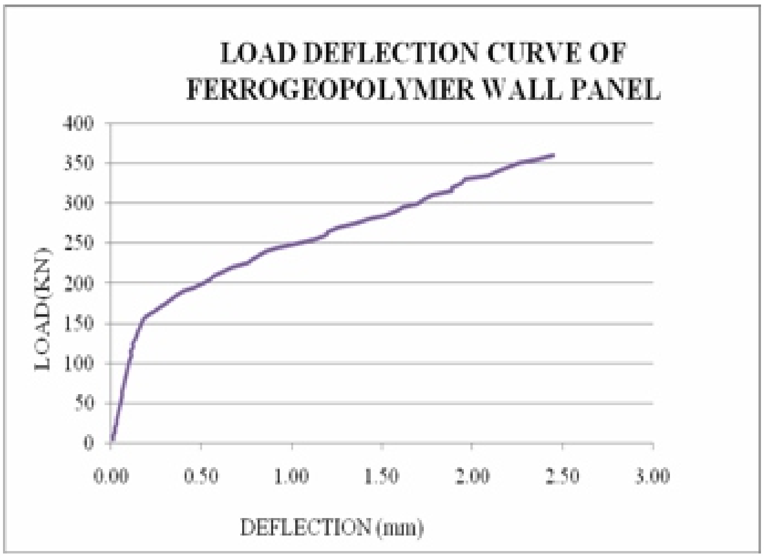


**Figure.6 Load Vs. Deflecton graph for ferro geopolymer wall panels**

## D. CEMENT SAVING AND SELF-WEIGHT AND COST REDUCTION

In ferro- geopolymer panels cement is totally replaced with flyash and it utilizes the geopolymer tehnology. So there will be a large reduction in the cost when we consider the binder part. No utilization of coarse aggregate, hence there will be much reduction in the self weight. Hence these precast members are easy to place on the site without any mechanical supports. Again coming to the manufacture part, no much skilled labours are required for the casting of panels. For ferro geopolymer panels water curing is not required. So this technique is more economic compared to the normal ferrocement panels.

## VIII. CONCLUSIONS

Based on the experimental study conducted on panels the test result obtained, the following conclusions were drawn:

1. The ultimate load carrying capacity of Ferro Geopolymer panels are high.

2. Pecast construction will helps in the massive production of building units very easily.

3. Less skilled labours are enough to work on.

4. Its very easy to cast and to place in position.

5. Economy and reduction of weight in panels depends on the replacement of reinforced concrete with ferro cement

6. Expected loads can be gained in the early stages of curing for both types of specimens.

## IX. SCOPE OF FUTURE STUDY

- Corrosion studies, compressive strength with various types of meshes, and strength under multiaxial loading contiditions can be done.

- Long term durability property of Ferro Geopolymer can be studied

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# Design Characteristics And Operational Aspects Of Cast Net Of Wular Lake Of Kashmir

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Professor & Head, Department of Fisheries Engineering, College of Fisheries, Shirgaon, Ratnagiri – 415 629, India.

## A B S T R A C T

*Cast net design characteristics, construction aspects and operational techniques were studied of Wular Lake of Kashmir. The netting material found to be used for the construction of Cast net was PA multifilament. Cast net with 3 to 4 panels were found joined together by seaming. The total length of the net was found varying between 3.70 to 5.70m. Cast net was used to catch large adult fishes of Schizothorax and Cyprinus spp. The cast net was operated throughout the day with the number of casts ranging from 50 to 60 per day. The average catch from cast net per day was 6 to 10kg.*

***Keywords – Cast Net, Fish Catch, Kashmir, Wular Lake***

## 1. INTRODUCTION

Cast net is one of the oldest and most widely used gear throughout the world. Cast net is a type of falling gear. It's a circular net weighted around its periphery by lead sinkers and thrown skilfully into the water so that they fall flat upon the surface water and rapidly sink. Cast net with pockets were in operation in the Wular Lake.

Wular Lake is the largest freshwater lake within river Jhelum basin and plays a significant role in the hydrography of the Kashmir valley by acting as a huge absorption basin for flood waters. Wular Lake with its associated wetlands supports rich biodiversity. It is a major fishery resource in the valley supporting a large population living along its fringes. Some of the economically important fish species of Wular Lake are Schizothorax esocinus, Schizothorax curvifrons, Schizothorax micropogon, Schizothorax niger, Schizothorax longipinus, Schizothorax richardsoni, Nemacheilus spp, Cyprinus carpio communis and Cyprinus carpio specularis. While Genus Scizothoracthyis is endemic to Wular Lake, Common carp was introduced in 1959 (Qureshi et al., 2014).

Cast net and its design was studied by Saxena (1966) in the middle reaches of Ganga river system of India. On the Himalyan frontier, Srivastav et al., (2002) recorded fishing by cast net in the streams of the Kumaon region of India. Kar et al., (2007) described cast net as traditional riverine fish catching device of Assam with regards to its structure, operation and selectivity. Therefore, the present study is undertaken with the objective of documenting the scientific design, technical specifications and mode of operation of cast net.

## METHODOLOGY

Wular Lake is located 34km northwest of Srinagar city at an altitude of 1,580m above mean sea level between 34°20" N latitude and 70°24" E longitude. It is elliptical in shape with a maximum length of 16km and breadth of 7.6km. The lake is surrounded by high mountainous ranges on the north eastern and north western sides (CMAP, 2007). Information on cast net was collected along the Wular Lake. All relevant data about the cast net was collected through field survey with the help of local fishermen. The procedure for specific research includes selection of study area, sampling unit, sampling procedure, data collection and appropriate statistical analysis. Eight fishermen villages/ landing center were selected for data collection (Fig 1).


**Fig 1 Map Showing Fishermen Villages / Landing Centers Used For Operation Of Cast Net In Wular Lake.**

The data collection at Wular Lake was carried out from the month of August to March, 2015. Fishing is done throughout the year except during winter season when there is a heavy snowfall and the temperature sometimes reaches very low resulting in freezing of some parts of Wular Lake. The design details of cast net was prepared and presented as per FAO catalogue of Fishing Gear Designs (Nedelec, 1975).

## RESULTS AND DISCUSSION

Cast net was most commonly observed gear being operated throughout the Wular Lake. The net was operated sporadically throughout the year. Different mesh and pocket sizes were encountered. Cast nets were locally known as Gol zal. The net was operated from small and medium sized fishing craft by a single fisherman. The cast net was operated throughout the day with the number of casts ranging from 50 to 60 per day. The average catch from cast net per day was 6 to 10kg. The operation usually started in the early morning. The net was thrown and then hauled as soon as it touched the bottom with the help of a pulling cord. The setting and hauling of the net was carried out from the stern of the boat. The fishes trapped in the pockets were removed either manually or with the help of a scoop net. Design and specifications of the cast net operated from Wular Lake are shown in the Table 1 the design in Fig 2 and 3.

The net was conical shaped and was fabricated with PA 210D×2×2 or 210D×6×3 polyamide multifilament. Similar type of PA twine with specification 210×2×2 was used for construction of cast net, was reported by Rajeswari et al., (2015) from Tandava reservoir, Andhra Pradesh. The current study revealed that for all panels of main webbing of cast net, mesh size varied from 40 to 50mm. Mesh size of smaller range i.e. 5 to 30mm for cast netlocally known as 'Jhinguri' was seen by Srivastava and Srivastava, (2011) in Suraha Lake, Uttar Pradesh. Srivastava et al., (2002) recorded that, the mesh size of cast net from the streams of Kumaon Himalayan region, varied from 10 to 50mm. Emmaneul et al., (2008) reported the cast net with mesh size of 30mm operated in Lagos lagoon of Nigeria.

**TABLE 1 SPECIFICATION OF CAST NET OPERATED FROM WULAR LAKE**

| **Local name of cast net** | ***Gol Zal*** |
|---|---|
| Local name of craft used for operation | *Naav* |
| No. of fishermen required for operation | 1 |
| Material of webbing | PA Multifilament |
| Specification of webbing | 210D×2×2/210D×6×3 |
| Colour of webbing | White |
| Selvedge mesh size (mm) | 63.75±6.73 |
| Number of pockets | 91.38±10.94 |
| Length of pockets (m) | 0.36±0.03 |
| Mesh no. of pocket | 286.25±24.99 |
| Sinkers per pocket | 3.87±0.13 |
| Material of sinker line | Polyethylene |
| Diameter of sinker line (mm) | 5-8mm |
| Length of sinker line (m) | 20.54±1.13 |
| Material of pulling chord | Any available textile material |
| Length of pulling chord | 1.06±0.24 |
| Local name of sinker | *Mani kor* |
| Number of sinkers | 349±30.02 |
| Material of sinker | Lead/Iron |
| Shape of sinker | Cylindrical |
| Weight of sinker | 33.13±2.48 |
| Distance between sinkers (mm) | 38.75±2.95 |

Okoh et al., (2007) reported the use of cast net having length varying from 3.31 to 4.61m, with a mean length of 3.367 ± 0.55 of a tropical lotic freshwater ecosystem, of Nigeria. Dutta et al., (2012) reported a standard cast net Khewali jal in Brahamputra River, which was smaller in length as compared to cast net operated in Wular Lake i.e. 2.5m. The length of cast net operated in Wular Lake ranged from 3.7 to 5.7m with an average of 5.01±0.22.

Emmanuel et al., (2008) studied cast net in tropical open lagoon and found that, PVOH (Polyvinyl alcohol) rope with 3 mm diameter was used as foot rope to which 71 numbers of lead sinkers were attached at regular interval each weighing 9g. On the contrary, the present study revealed that the sinker line was made of polyethylene of diameter 5 to 8mm in Wular Lake.

During the present study, the number and length of pockets were found to be ranging from 60 to 150 and 0.3 to 0.5m, respectively. In a similar study, a total of 91 number of pockets which were within the range as observed in the present study were reported by Saxena, (1966) from Ganga river system which were made by folding the net inwards to about 61/2 meshes in depth.

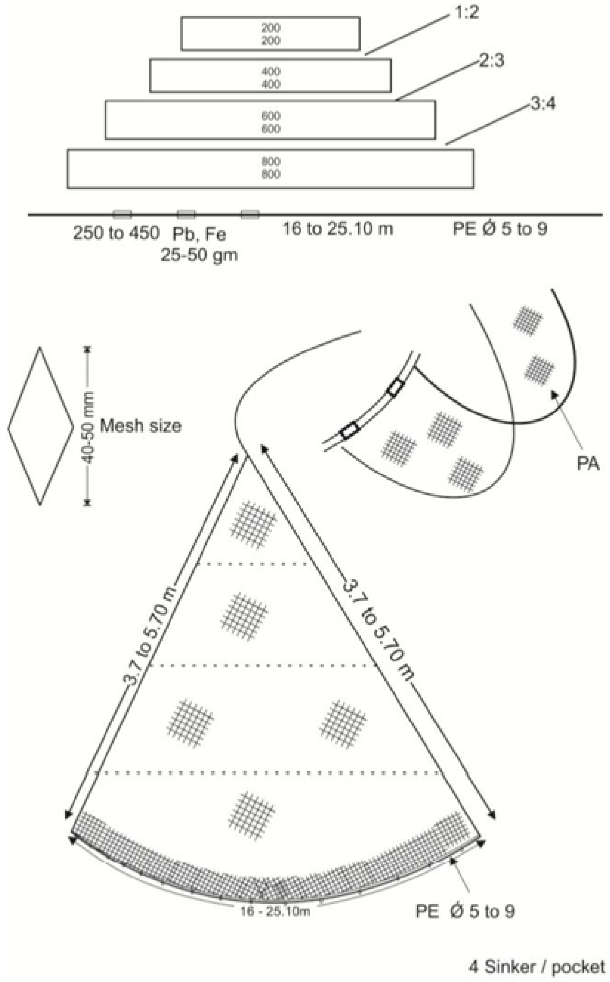


**Fig 2 Design of Cast Net Operated From Wular Lake**

Attachment of apex to the bridle

Arrangement of pockets

Attachment of sinkers

Operation of Cast net

**Fig 3 Gear Accessories, Rigging And Operation Of Cast Net**

## CONCLUSION

The documented information on the design, technical specifications and operation of Cast net operated in Wular Lake of Kashmir, would serve as a base line information for the technological modifications this gear may undergo to increase its efficiency in the coming years.


## ACKNOWLEDGEMENTS

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# Comparative Horizontal Retaining Force Of Conventional And Interlocking Concrete Block Retaining Wall

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## A B S T R A C T

*Comparative horizontal retaining force tests were conducted between regular and interlocking concrete block free standing retaining wall sections 1.63 m (64") high and 2.44 m (96") wide. The centrally loaded horizontal force was applied using the 793 Series MTS linear Actuator. The force and corresponding wall deflection was logged at one second intervals until structural wall failure. Experimental results indicated that the free standing interlocking block retaining wall section resisted a higher horizontal force ranging from 32.5% to 66.3% when compared with the regular concrete block wall section. The interlocking block wall section showed an average of 46.5% higher horizontal retaining force then the regular block wall. There were no significant difference in the wall deflection at which structural failure occurred for the regular concrete block wall and the interlocking concrete block wall.*

***Keywords – Retaining wall, Interlocking blocks, Concrete blocks, Horizontal force.***

## 1. INTRODUCTION

In general landscaping retaining walls are structures designed and constructed to resist the lateral pressure of soil and keep it in place when there is a desired change in ground elevation that exceeds the angle of repose of the soil [1]. There are different designs of retaining walls suited for respective applications [2]. However, the most important consideration in proper design and installation of retaining walls is to ensure that the wall counteract the tendency of the retained material to move downslope due to gravity. The downslope movement of the retained material creates lateral earth pressure behind the wall [3]. The magnitude of this pressure depends on the angle of internal friction, the cohesive strength of the retained material, as well as the direction and magnitude of movement the retaining structure undergoes [4].

Some special purpose walls are designed to retain water, however, in general it is important to have proper drainage behind the wall in order to limit the pressure due to water retention. Accommodation of drainage materials or design consideration will reduce or eliminate the hydrostatic pressure and improve the stability of the material behind the wall [5]. Without a pressure-relief system, the weight of the water in the soil could crack, or even buckle, the wall. Drystone retaining walls are normally self-draining. Weep holes incorporated in the wall along the top of the first course can channel some of the water out. Other designs include a plastic drainpipe covered with gravel [6].

Concrete blocks are commonly available material that are ideal for building small scale retaining walls to hold back the soil after digging into a slope for a pathway, patio, or other small projects. Retaining walls constructed from standard blocks are generally the same as freestanding block walls. However, since the retaining wall has a horizontal force to resist it must be stronger than freestanding walls [7]. To improve the wall strength a rebar is insert in the footing of the wall which is accommodated in the core of the blocks. Usually at every three blocks high intervals the cores around the rebar are filled with mortar from the bottom to top [8]. The conventional concrete blocks has a square edge and during wall construction the blocks are placed together with a layer of mortar between to hold it in place [9]. In this study, an interlocking concrete block design that do not require mortar between consecutive horizontal blocks was used to construct a retaining wall section. The horizontal retaining wall force was tested and compared to a conventional block retaining wall section under similar test conditions.

## 2. EXPERIMENTAL PROCEDURE

Two retaining wall sections with different concrete block designs were constructed for comparative testing. The first wall design was constructed with the regular commercial concrete block of dimensions 152 mm x 203 mm x 406 mm (6”x8”x16”) as shown in Figure 1.

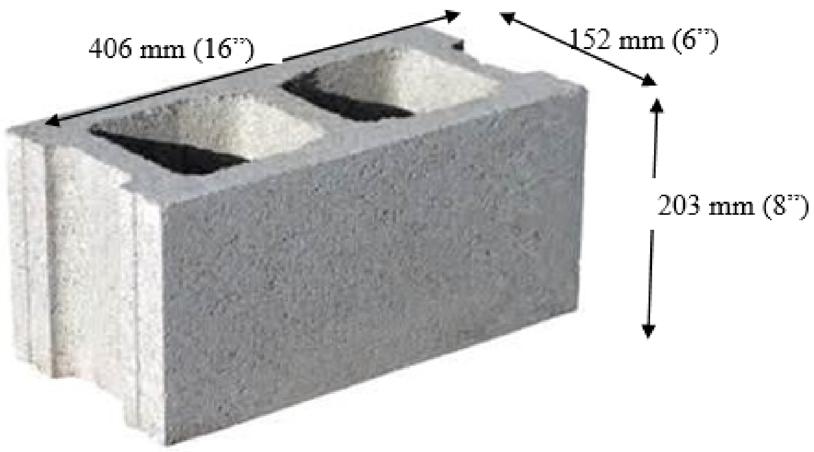


**Figure 1. Regular conctete block**

A 13 mm (½") steel rod was centrally installed in the vertically core of each block. The Cores of the blocks wall were filled with pliable concrete at three block height intervals. During the core filling process the concrete was prodded to ensure proper and complete filling of the cores. Figure 2 shows a wall section under construction. Three test wall sections 1.63 m (64") high and 2.44 m (96") wide was constructed. Each test wall section was allowed to cure for seven days before testing.

**Figure 2. Regular concrete test wall under construction**

The second wall design was constructed with the interlocking concrete block of dimensions 152 mm x 203 mm x 406 mm (6"x8"x16") as shown in Figure 3.

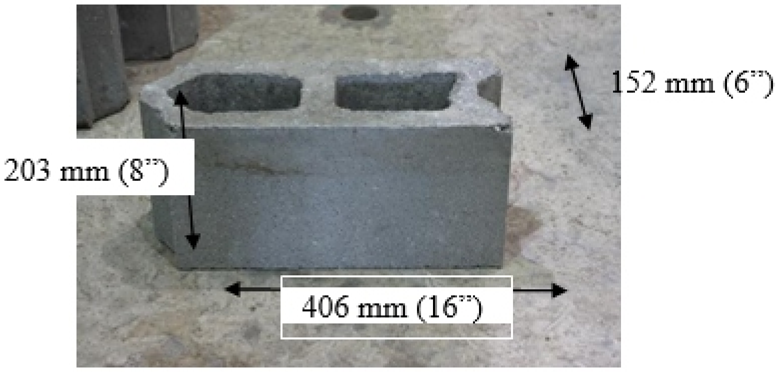


**Figure 3. Interlocking conctete block**

A 13 mm (½") steel rod was centrally installed in the vertically core of each interlocking block. The Cores of the interlocking blocks wall were filled with pliable concrete at three block height intervals. During the core filling process the concrete was prodded to ensure proper and complete filling of the cores. Three test wall sections 1.63 m (64") high and 2.44 m (96") wide was constructed. Figure 4 shows a completed interlocking block wall section after construction. Each test wall section was allowed to cure for seven days before testing.

**Figure 4. Completed interlocking block wall section with rebar**

The retaining wall sections were 'simply-supported' vertically at both ends. The distance between the vertical restraining bars was 2 m. The base of the walls rested freely on a smooth 18mm thick steel plate to simulate a free standing wall section. To simulate the force exerted from the backfill material a centrally placed horizontal force was applied to the wall section. Figure 5 shows a schematic of the test set-up.

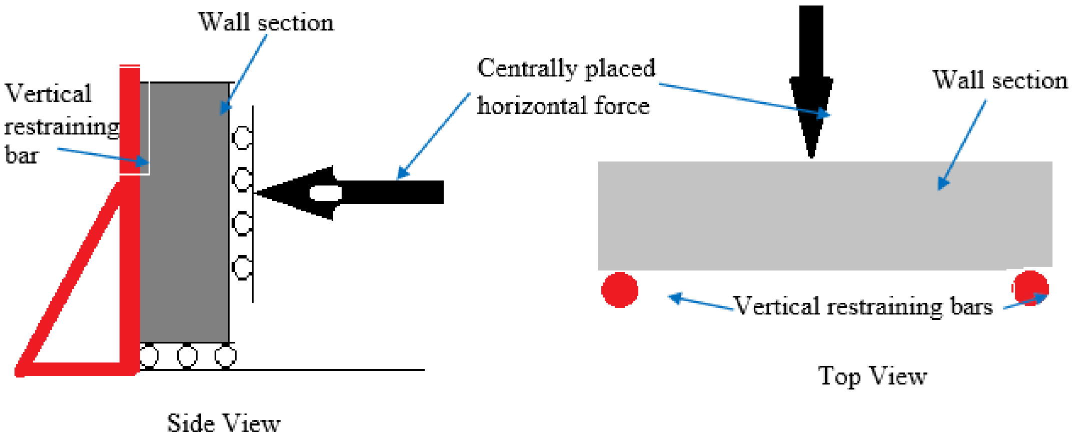


**Figure 5. Schematic of wall section test set-up.**

Comparative retaining force tests were conducted on the six cured retaining wall sections. The apparatus used to apply the horizontal force was the 793 Series MTS Actuator. This linear actuator measured simultaneously the horizontal force (N) (± 0.1N) and the respective wall deflection (mm) (±0.01 mm). Once the test started the apparatus was automatically controlled by a computer that recorded the force and corresponding wall deflection data at one second intervals. Each test proceeded until the wall failed.

## 3. RESULTS

Each cured specimen of the free standing retaining wall sections, simply-supported vertically at both ends, was tested to determine the horizontal retaining force. The specimens were subjected to a centrally located horizontal force using the 793 Series MTS Actuator apparatus and the variation of horizontal force with horizontal wall displacement was recorded automatically by the computer at one second intervals until the wall section was broken. The test results for the three wall sections constructed with the regular concrete blocks with 13 mm vertical rebar in the core filled with concrete are shown below in Figures 6 to 8. The maximum retaining force and corresponding displacement for each test are noted.

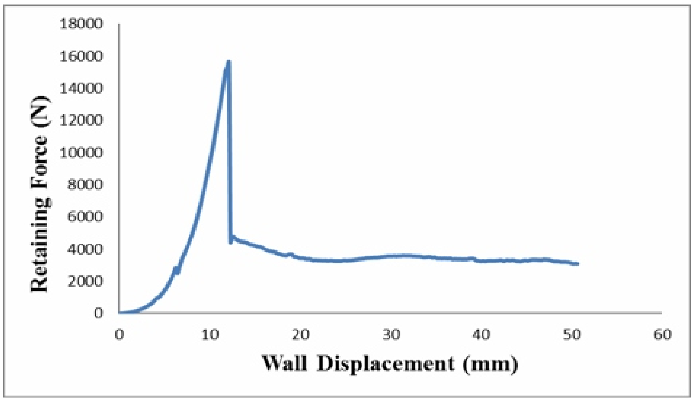


**Figure 6. Regular Concrete Block Wall with Vertical Steel rebar concrete filled core – Sample 1.**

The test results shown on Figure 6 indicated a Maximum retaining force 15600.59 N at a wall deflection of 12.1681 mm. Structural failure occurred beyond this point.

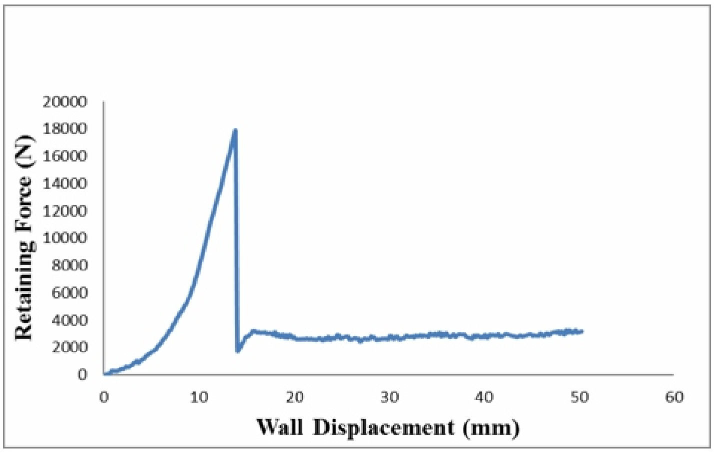


**Figure 7. Regular Concrete Block Wall with Vertical Steel rebar concrete filled core – Sample 2.**

The test results shown on Figure 7 indicated a Maximum retaining force 17835.47 N at a wall deflection of 13.8286 mm. Structural failure occurred beyond this point.

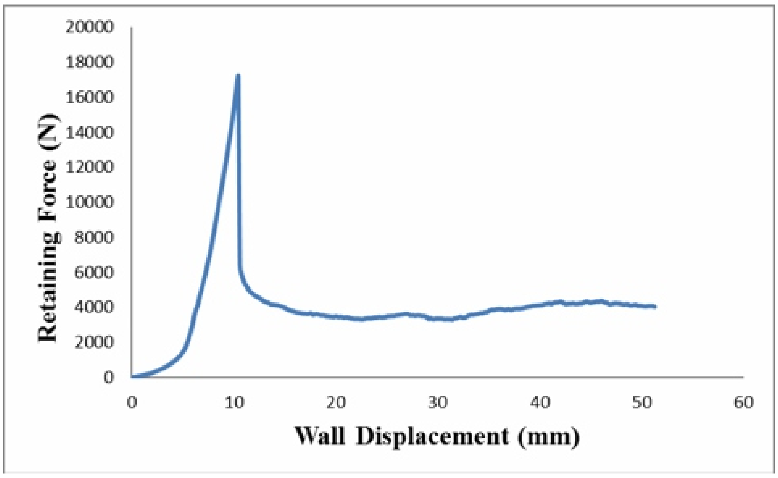


**Figure 8. Regular Concrete Block Wall with Vertical Steel rebar concrete filled core – Sample 3.**

The test results shown on Figure 8 indicated a Maximum retaining force 17149.73 N at a wall deflection of 10.4950 mm. Structural failure occurred beyond this point.

The average retaining force for the regular concrete block wall with vertical steel rebar and concrete filled core was calculated as 16862 N at an average wall deflection of 12.2 mm.

The test results for the three wall sections constructed with the interlocking concrete blocks with 13 mm vertical rebar in the core filled with concrete are shown below in Figures 9 to 11. The maximum retaining force and corresponding displacement for each test are noted.

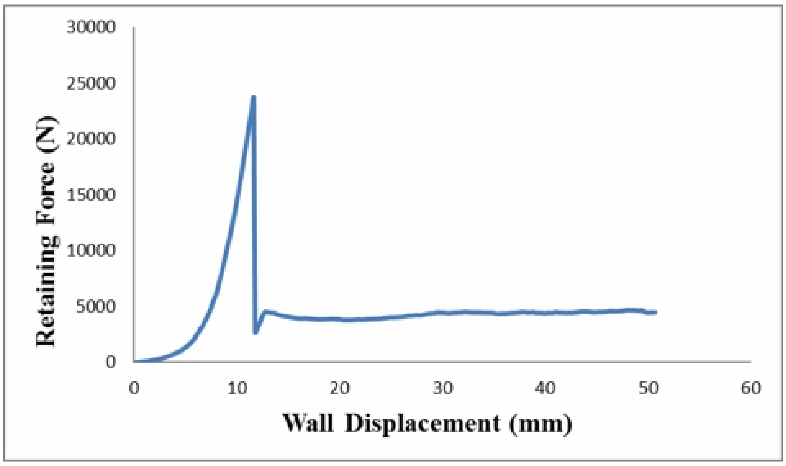


**Figure 9. Interlocking Concrete Block Wall with Vertical Steel rebar concrete filled core – Sample 1.**

The test results shown on Figure 9 indicated a Maximum retaining force 23637.81 N at a wall deflection of 11.6664 mm. Structural failure occurred beyond this point.

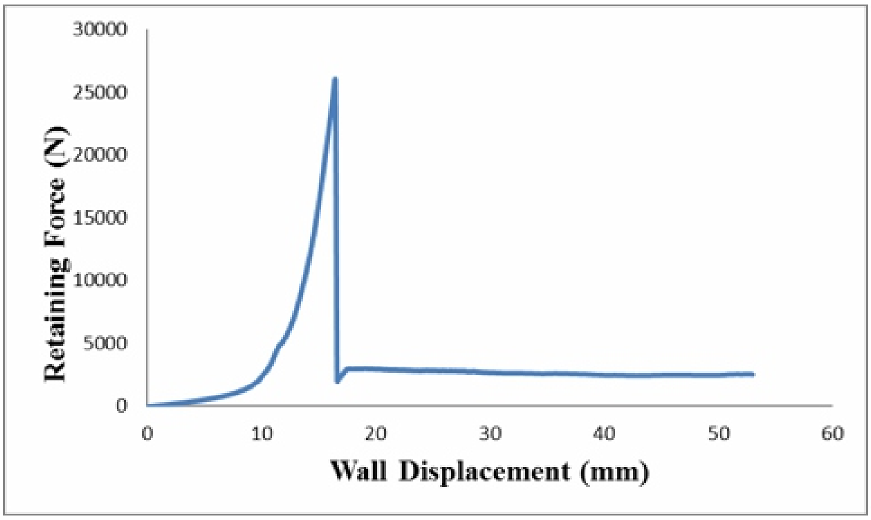


**Figure 10. Interlocking Concrete Block Wall with Vertical Steel rebar concrete filled core – Sample 2.**

The test results shown on Figure 10 indicated a Maximum retaining force 25942.31 N at a wall deflection of 16.5014 mm. Structural failure occurred beyond this point.

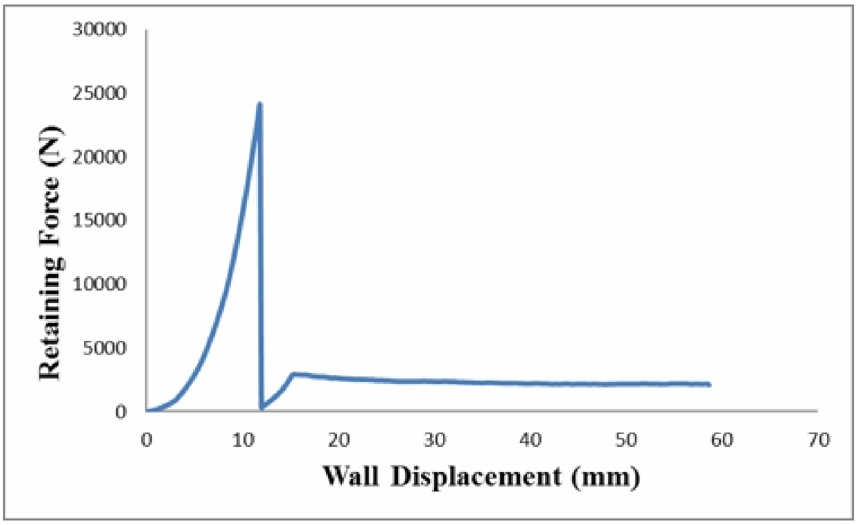


**Figure 11. Interlocking Concrete Block Wall with Vertical Steel rebar concrete filled core – Sample 3.**

The test results shown on Figure 11 indicated a Maximum retaining force 24059.28 N at a wall deflection of 11.8328 mm. Structural failure occurred beyond this point.

The average retaining force for the interlocking concrete block wall with vertical steel rebar and concrete filled core was calculated as 24546 N at an average wall deflection of 13.3 mm.

## 4. DISCUSSION

Regular concrete blocks are convenient and easily available for the construction of retaining wall structures. The practice of using vertical rebar with concrete filled core are the norm for concrete block retaining walls. The use of mortar during construction is to hold the blocks in place and ensure proper alignment. The mortar joining is not a structural force bearing attachment. The interlocking block design accommodated for load bearing joint where the blocks interlocked. At this junction the adjacent pre-cast concrete blocks make direct contact which would resist horizontal force loading.

The experiments were designed to simulate a horizontal force loading on a free standing retaining wall section as shown in Figure 5. The test results for the three regular concrete block wall sections ranged between 15600 N to 17835 N with an average horizontal retaining force of 16862 N at a mean wall deflection of 12.2 mm at the center of the wall. The test results for the three interlocking concrete block wall sections ranged between 23637 N to 25942 N with an average horizontal retaining force of 24546 N at a mean wall deflection of 13.3 mm at the center of the wall.

All three interlocking retaining wall section showed a higher horizontal retaining force than the three regular retaining wall sections. From the test results the minimum difference in horizontal retaining force between the regular and interlocking block walls was 5802 N or 32.5%. The maximum difference in horizontal retaining force between the regular and interlocking block walls was 10342 N or 66.3%. The difference between the mean horizontal retaining force between the regular and interlocking block walls was 7684 N or 45.6%. Structural failure on the average for all the walls was 12.7 mm. There were no significant difference in the structural failure deflection between the regular concrete block wall and the interlocking concrete block wall.

## 5. CONCLUSIONS

The interlocking concrete block design forms a horizontal retaining force load bearing joint between adjacent blocks. The free standing interlocking block retaining wall section showed a higher horizontal retaining wall force ranging from 32.5% to 66.3% when compared with the regular concrete block wall section. On the average, the interlocking block wall section showed a 46.5% higher horizontal retaining force then the regular block wall. On the average, structural failure under horizontal force loading occurred at about 12.7 mm deflection for both the interlocking and regular concrete block wall sections.

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