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An Experimental Evolution of Impact Strength Of Fiber Reinforced Concrete By Using IS Drop Weight Test Method

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Abstract : This includes the study of impact resistance of fiber resistance of reinforced concrete using IS drop weight test method on FRC and HFRC slab panels having different types of fiber with their different proportion. A present review paper discussion of results of IS drop weight test method conducting low velocity and high velocity impact properties and record spilling area also scabbing area. The deformability, toughness and energy absorption of FRC are of great interest characterized these parameter test are carried out on concrete slab panel are most commonly used. Concrete structures are often subjected to short duration (dynamic) loads. Such loads originate from sources such as impact from missiles and projectiles, wind gusts, earthquakes and machine vibrations, vehicles. Due to a relatively low tensile strength and fractures energy impact resistance of concrete is poor. Hence much research has been directed towards developing concrete that exhibit improved impact resistance than conventional concrete. By using drop weight test method determining the initial and final cracking.

Keywords: Corrugated steel fiber, glass fiber, polypropylene fiber, impact machine.

I. Introduction

Concrete is the most important material used in construction worldwide. Concrete is a composite material consisting mostly cement, Water, coarse aggregate and fine aggregate. Conventional concrete used has low tensile strength and make it brittle used in construction. This limitation in concrete makes it to crack under minute loads, at the tensile end of the member

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To increase the tensile strength of concrete, several efforts have been made. The most commonly used method is providing steel reinforcement in the concrete members. Steel bars reinforced concrete only against local tension. Thus, need arises for multi-directional and closely spaced steel reinforcement in the concrete. This is not practically achievable and it has some drawbacks such as limited ductility, lesser impact, abrasion resistance and little resistance to cracking. There is a need to overcome these problems in the modern construction field and reinforcing fibres into the concrete shows promising solution to overcome those problems.

II Fiber Reinforced Concrete and Hybrid Fiber Reinforced Concrete

Fibre Reinforced Concrete (FRC) that has fibrous material which improves structural integrity of a concrete. It incorporates little Discrete filaments that are homogeneously scattered having certain trademark Properties The term FRC is characterized by ACI Committee 544 [4] as a solid made of water hydraulic cement containing fine and coarse totals and Discontinuous discrete fibers. The typical FRC mixture is shown in Figure 1.1. Fibres Consists of steel fibres, glass fibres, polypropylene fiber. The percentage of amount of fibres added to a concrete mixture is measured as a percentage of the total volume of the Composite termed as fibres volume fraction (Vf). The fibres is usually described By a suitable parameter called “aspect ratio”. The aspect ratio of the fibres is the Ratio of its length to diameter. Usually, fibres have high length compared to their diameter. The major reason for incorporating fibres into a concrete is to produce greater impact strength, bond strength, increase the tensile strength, toughness, ductility, energy absorption capacity and improves the deformation characteristics of concrete.

Hybrid Fibre Reinforced Concrete (HFRC) is an improved form of concrete which can be prepared using a different combination of fibres. The mixture of steel and polypropylene fibres with concrete is shown in Figure 1.3. The mixture of fibres is often called as hybridization and mainly depends on implementation of suitable fibres combination. It has been demonstrated as of late (Xu and Hannant [94]; Kakemi and Hannant [49]; Mobasher and Li [57]) that by utilizing the idea of hybridization with two different fibres incorporated into a cement matrix, the hybrid composite can provide more remarkable engineering properties because the existence of one fibres enables the most proficient utilization of the potential properties of the other fibres. Ganesan et al. [30] found that the use of hybrid fibres in concrete arrests the micro cracks as well as macro cracks. Low modulus fibres arrests the micro cracks and control the formation of macro cracks, where as high modulus fibres control macro cracks.

III Impact Load

Impact load is defined as "Collision between two objects on each other in small duration." Impact loading is characterized by a very rapid input of energy. The overall tensile stress increases rapidly and leads to high concentrations of stresses at existing imperfections in the material. The importance of impacts loads and impulsive loads, such as those occurring in accidental conditions,

- Rock fall on a concrete shelter,
- Vehicles or ships in collision with buildings, bridges or offshore infrastructures,
- Aircraft impact on nuclear containments or those occurring in terrorist or military conditions, missile impact, blast wave due to an explosion, etc.,

It is an increasing pre-occupation in the design of reinforced concrete (RC) structures. Impact covers a wide range of loadings, two limiting cases: Hard and Soft impacts.

3.1 Impact Capacity

Impact capacity is a function of the load-time and is related more closely with energy absorption than with a maximum measured load. In measuring the static capacity of a section the load is gradually increased until a maximum load is reached and is denoted as the capacity. Impact loadings considerably different in nature the applied load is measured highest initially with load decreasing as time continues until all energy from the impact is absorbed. As the extreme loads that are immediately induced are well above the yield capacity, stress level is not an adequate indication of impact member response.

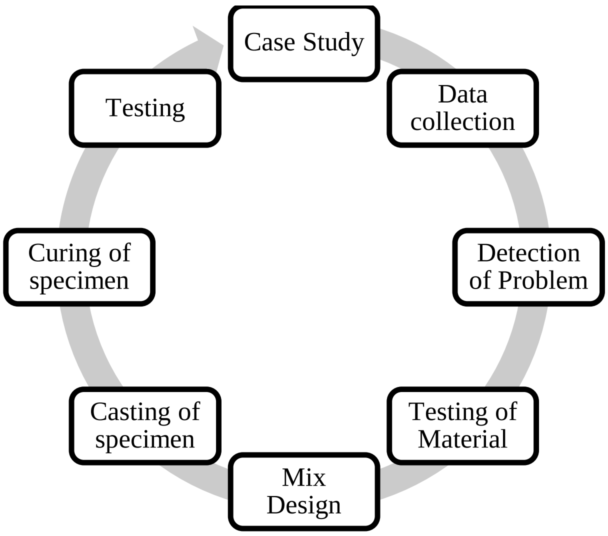
3.2 Causes of Impact Loading

- Continuous landing and takeoff of aircrafts.
- Continuous traffic of heavy vehicles.
- Impact of sea waves on seashore structures.
- Excavation by heavy equipment near adjoining structure.
- Highway accidents.
- Loading and unloading of heavy containers in industrial zones.
- Demolition of structures.
- Shocks and vibration to railway sleepers.

3.3 Objective of impact loading

- To investigate the properties of fiber reinforced concrete, to check the behavior of fiber reinforced concrete under impact load test.
- To study the relation between impact load and number of blows and weight of hammer on slab.
- The main target of this study is to provide guidance to engineers and architects where there is a necessity of protection against impact loads, therefore providing protection for human, structure and the valuable equipment inside.
- This study is motivated from making buildings in impact resistant way, pioneering to put the necessary regulations into practice for preventing human and structural loss due to the impact and other human-sourced hazards.
- Develop stronger, safer and more cost-effective structures for the new generation
- To analyze and design the structures against the abnormal loading conditions like blast loads, strong wind pressure etc. requiring detailed understanding of blast phenomenon.
- To study the dynamic response of various structural elements like column, beam, slab and connections in steel and RCC structures.

VI Research Methodology



6.1 MIXING, CASTING AND CURING OF SPECIMENS

The mixing of various FRC was done as fallows. Initially cement, sand, aggregate and water were discharged into the concrete mixer. As the above ingredients were getting mixed, the required quantity of fiber were added manually to the above wet mix in the mixer and the mixing was continued.

The impact resistance of various FRC specimens at various ages like, 28 days was assessed. Nine disc specimens were cast for each series. While casting the test specimens, fifteen cubes of size 150 X 150 X 150 mm and thirteen slab panel's size 50 X 50 X 5 cm were also casted. Four test specimens were tested for each variable. In all, 30 specimens were cast for the investigations. The specimens were cast in metal Moulds and the compaction was effected through a table vibrator. In the test procedure recommended by ACI Committee 544, it is suggested that for fibers longer than 31.8 mm, the test specimens should be cut from full cylinder to obtain random orientation of fibres. Individually cast test specimens used for the present investigation. However, to eliminate the effect of possible fibre orientation, Moulds were initially half filled, the mix was vibrated and then other half was filled and vibration was continued. No sign of segregation or air bubbles were observed during casting. The specimens were demoulded after 24 hours and cured by immersing them in water for curing of 28 days.

6.2 Casting and curing of Test Specimen

Test specimens were casted using different types of such as steel fiber, polypropylene fiber, glass fiber percentage of fibers added in concrete, namely 0.5%, 1.0%, 1.5%, 2.0% percent for each of the three types of fiber (Corrugated steel fiber, hooked end steel, Polypropylene fiber). Companion specimen in plain concrete was also cast. Ordinary Portland cement conforming to IS, crushed sand, kuch and coarse aggregate with 10 mm maximum size were used. The mix was designed for a 28 day cube compressive strength of 20 $N/mm^{2.}$

The test and control specimens were demoulded after 24hours, and cured according to ACI 308.1. The specimens were cured for about 28days, and then left in air temperature and humidity inside the laboratory until the date of testing.

VII Testing Procedure

7.1 Indian Standrd Drop Weight test Method

1. Thickness of the specimens was recorded to the nearest millimetre at its centre and at the ends of a diameter prior to the test.
2. The hardened steel ball was placed on the centre mark of slab panel test specimen within the bracket. The positioning of stand to restricts movement of the specimen during testing to the first visible cracks.
3. The drop hammer from 2m height then placed with its base upon the steel ball and held vertically. The hammer was dropped repeatedly from 2m height, and the numbers of blows required for the first visible crack to form at the top surface of the specimen and for ultimate failure were recorded.
4. To carry out the test satisfactorily, the stand needs to be held rigidly and this was achieved by securing it firmly on to a large reinforced concrete slab panel of size 50 X 150 X 5 cm.
5. The first crack was based on visual observation and also final crack is visible.
6. Ultimate failure is defined in terms of the number of blow required to open the cracks in the specimen sufficient to enable the fractures pieces to touch three of the four positioning lugs on the base plate.
7. The stage of ultimate failure is clearly recognized by the fracture specimen against were slab panel stand. With fiber reinforced concrete specimen, the pieces were not often broken clearly, whereas in plain concrete samples, specimens were broken into separate pieces.

Fig. Initial and Final cracking of slab panel

VIII Result

Addition of different types of fiber such as steel fiber, polypropylene fiber, glass fiber at 0.5%, 1%, 1.5%, 2% it was observed that as compared to conventional concrete impact strength of fiber reinforced concrete is more.

Table no.1: Impact strength of corrugated steel Fibre

28 DAYS	CORRUGATED STEEL FIBRE				
Steel Fibre (%)	00%	0.5%	1%	1.5%	2%
First crack	1	1	2	2	3
Impact strength for First crack(Nm)	117.72	117.72	235.44	235.44	353.16
Ultimate failure	2	3	4	5	8
Ultimate failure impact strength(Nm)	235.44	353.16	470.88	588.66	941.76

Table.2:Impact strength of glass fibre

28 DAYS	GLASS FIBRE				
Glass fiber (%)	0%	0.5%	1%	1.5%	2%
First crack	1	1	1	1	2
Impact strength for First crack(Nm)	117.72	117.72	117.72	117.72	235.44
Ultimate failure	1	1	2	3	3
Ultimate failure impact strength(Nm)	117.72	117.72	235.44	353.16	353.16

Table No.3: Impact strength of polypropylene fibre

28 DAYS	POLYPROPYLENE FIBRE				
Polypropylene fiber (%)	00%	0.5%	1%	1.5%	2%
First crack	1	1	1	2	2
Impact strength for First crack(Nm)	117.72	117.72	117.72	235.44	235.44
Ultimate failure	2	2	2	3	4
Ultimate failure impact strength(Nm)	235.44	235.44	235.44	353.16	470.88

8.1 Sample calculation of compression test –

Compressive Strength (N/mm^2) = Load (N) / Area (mm^2)

a) 792.6 KN = (792.6x1000 N)/ (150x150) = 35.20 N/mm^2

b) 853.2 KN = (853.2x1000 N)/ (150x150) = 37.90N/mm^2

c) 1000 KN = (1000x1000 N)/ (150x150)= 44.44N/mm^2

d) 1027.2 KN = (1027.2 x1000 N)/ (150x150) = 45.60N/mm^2

IX Conclusion

- It was found that increases volume of steel fibers leads to increase in impact resistance.
- The impact resistance increased also increased against the first visible crack and final crack which means that energy absorption capacity in concrete with steel fibers increased.
- By incorporation of different types of fibbers, failure mode was changed from brittle to ductile behaviour, which displays beneficial effect of FRC used in structural engineering application

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