Effect Of Material Properties On Fatigue Behavior Of Fiber Reinforced Self Compacting Concrete Beam

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Abstract— concrete structure Strengthening by using Carbon Nano tube , steel fiber and dust of cement addition that material to the design mix , are become an increasingly accepted method in structural engineering applications, especially for concrete members subjected to repeated load such as bridge girders. This research investigates the behavior of eight self-compacted reinforced concrete beams under monotonic loads. All beams have (150mm) width, (250mm) height and (1650 mm) length . that have two beam design mix (that the reference beam) and the other beam (6 beams) we have the mix design and addition that one's of material (carbon Nano tube , steel fiber and dust of cement).Two Self-Compacting Concrete (SCC) mixtures are used in this study . The mixtures are designed using different material proportions to evaluate two different compressive strength (79) and (32) MPa, which is considered as a variable in present study. The results of the Practical program displayed that the beam have steel fiber reinforced strengthening increase the flexural resistance of the strengthened beam subjected to monotonic loads by repeated load tests, the number of cycles up to failure increase by (36.8%) for normal concrete and (70.7%) for high strength

Keywords: Fiber reinforcement; self-compacting concrete ,compressive strength, flexural strength, tensile strength, workability , concrete mix , superplastisizer ,

1. Introduction

Concrete technology is the important part in the structural building industry, therefore it's always under development to achieve the best properties. Many researches deal with concrete technology and study the behavior of concrete with changed conditions and study the factors that affect the properties of normal and high concrete and try to produce a new type of concrete with best properties. One of the disadvantages of concrete casted in the site is that its quality depend on the abilities of workers to cast and vibrate the concrete in the proper way. Therefore a special type of concrete was invented which decrease these effects is the Self Compacting Concrete (SCC)

2. Self-Compacting Concrete (SCC)

Self compacting concrete is very flow able , no segregating in concrete that can propagation into structure, top up the formwork, and encapsulate the reinforcement minus any mechanical unification [1]. On the other hand the hardened SCC is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete [2]. SCC has also been described as self-consolidation concrete, and self-leveling concrete. Casting concrete structures without vibration, have been done in the past. For examples, placement of concrete under water is done without vibration. Mass concrete, and shaft concrete can be successfully placed without vibration. But the above examples of concrete are generally of lower strength and difficult to obtain consistent quality. Modern application of self– compacting concrete (SCC) is focused on high performance, better, more reliable and uniform quality [3].In 1990, Japan has developed and used SCC that does not require vibration to achieve full compaction. By the year 2000, the SCC has become popular in Japan for prefabricated products and ready mixed concrete [3].

Figure 1. Casting of Self-compacting Concrete

3. History and Development of Self Compacting Concrete

The former times and growth of SCC can be separated into two key phases [4] : its initial expansion in Japan in the belated 1980s and its introduction into Europe over Sweden in the mid to belated -1990s.

In 1980, SCC was principal established in Japan in order to attain more durable concrete constructions by ameliorative the quality attained in the construction procedure and the positioned material. One of the main drivers for the development of the technology was the decrease in the number of deft site workers that the Japanese structures industry was experiencing. SCC, which can be compacted in to every corner of a formwork, purely by means of its own weight and without the need for vibrating compaction [5], [6]

In 1986, Ozawa [7]proposed the necessity of this type of concrete, and after that many research papers were published on SCC under different names, such as self consolidating, highly workable, self- placing and highly-fluidized concrete. They were carried out through Ozawa at the University of Tokyo. These were principally papers on work in the combination design of what would turn into "SCC" and its linked into fresh properties. Druta [8] started a study project on the flowing capacity and workability of this singular kind of concrete. The self compacted ability in concrete can be mainly affected by the features of materials and the combination proportions.

In 1988, the prototype of self-compacting concrete was first completed using materials already available in the market. The prototype performed satisfactorily with regarded to drying and hardening shrinkage, heat of hydration, denseness after hardening, and other properties. This concrete was named "high performance concrete" and was defined as follows at the three stages of concrete [6]:-

1)Fresh: self-compactable.

2)Early age: avoidance of initial defects.

3)After hardening: protection against external factors.

4. Carbon Nano tube

ever after their discovery in 1991, have manufacture a tremendous upheaval in various manufacture due to their eminent material properties, thorough great strength and little density. they are at present being considered by way of an stellar alternate for classic reinforcing fibers in the new generation of Nano composites. By Using CNTs in the mix to reinforce concrete may consequence in the manufacture of a rise strength material. specified that addendum of CNTs to cement bast could rise the compressive strength up u to 50%. Improving the fracture resistance , reducing the shrinkage and porosity and durability the cementitious based with CNT were other features of CNT addition. Experimental work consequence clarify that nanotubes could good advance in the compressive and f flexural strength and failure strain in cement matrix put together and reduction in porosity

Multi walled carbon nanotubes called (MWCNTs) have been inserted with cement pastes to study the influence what happen in to compressive strength and smash toughness. Cement based composites must been ready from Portland cement with different amounts of joint MWCNTs and MWCNTs with a carboxylate collection (MWCNTs...COOH), stretch from (0 to 0.1)% by weights. Nanotubes should be uniformly dispersed into cement paste through stratify ultrasonic energy device with the usage of surfactants. [36]

Carbon Nanotubes called (CNTs) are principally elemental carbon containing of curved grapheme layer which depend of a single layer of carbon atoms in a honeycomb farms that may have changing amounts of metal dirtiness, depending on the technique of production. So chose mwcnt from cheap company and when arrive the carbon Nano tube can't add to water so add addition admixture carboxylate to help carbon Nano tune to desperation in water

Table 1. Properties of MWCNTs used.

Parameter Unit MWCNT	
Purity	>95 wt. %
Outer diameter (OD)	20–30 nm
Length	10–30 um
Special surface area (SSA)	>200 m2/g
ASH	<1.5 wt.%
EC	> 10-2sl/cm
Sku#	030104

5. Steel Fiber

Steel fibers are used in concrete to improve the properties of concrete in hardened stage such as post cracking, tensile strength , flexural strength and toughness when add to concrete in two volume the present is 0.8 % for normal and high strength of concrete to the mix

Figure 2. Steel Fiber 5 cm length

6. Objective of the Present Work

The objective of the present work contain the following points:

1-Study the fresh and hardened properties of SCC for different mix proportions to be used in casting eight test beams.

2-Study the performance of beam strengthened with steel Fiber reinforcement, (FSR) under repeated loads and compare results with un strengthened beams.

3-Study the performance of beam strengthened with Carbon Nano Tube (MWCNT) under repeated loads and compare results with un strengthened beams.

4-Study the behavior of beams strengthened with Dust of cement (DOC) under repeated loads and compare results with un strengthened beams.

7. Mixing procedure of Carbon Nano Tube With Water

MWCNT with water / cement ratio was prepared 0.5% by weight of carbon Nano tube (MWCNT) were add to water and dispersed in water by applying ultrasonic energy . a 35 w cup – horn high intensity ultrasonic processor and used to apply constant energy 9000 j to the CNT dispersions, and control in temperature of room by make closed with air-condition open .ultrasonic processor was used as a 15 and 20 min with 35 % amplitude . after the sonication , add to percent to the mix of concrete the same show that in Figure 3

Figure 3. Machine of dispersion of carbon Nano tube in water

8. Splitting Tensile Strength: -

The splitting tensile strength is determined at 28 days on cylinders with (h=200mm, d=100mm) and moist cured in water until the date of test according to ASTM C496-86 .

The test is carried out by placing a cylinder sample horizontally between the loading surfaces of the compression testing device and the load is utilized failure of the cylinder, straight the vertical diameter, then magnitude the splitting tensile strength is mastered by the following equation:-

$$Ft = 2P / 3.14 \ LD \quad \ldots\ldots\ldots\ldots (1)$$

Where P: is the applied compressive load, (N)

L: is the cylinder length, (mm) and

D: is the cylinder diameter, (mm)

Splitting tensile strength (MPa) is obtained by averaging the results of three specimens.

Figure 4. Steel Fiber 5 cm length

Table 2. splitting tensile

Mix Symbol	Splitting Tensile Strength (MPa)
B1	2.812
B2	3.25
B3	4.042
B4	6.145
B5	3.351
B6	5.673
B7	2.96
B8	3.6

9. Flexural Strength:

Flexural strength is measured using the results obtained from a prism with four point loading rendering to the ASTM C 78-84[83], Test prisms measuring 100*100*400 mm are ready rendering to ASTM C192-88(81) but deprived of any compaction. The prisms are cast at the same conditions for the sample of the compressive strength .testing machine of 30000 kg capacities is used for this test. Flexural strength (MPa) is obtained by averaging the results of three specimens for age 28d.see that in Figure 5, Table 3

Figure 5. Machine of test flexural strength

Table 3. flexural strength

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Mix Symbol	Flexural Strength (MPa)	Mix Symbol	Flexural Strength (MPa)
B1	3.137	B5	4.95
B2	4.666	B6	7.138
B3	4.229	B7	4.185
B4	6.44	B8	5.958

10. Preparing and Curing of Test Specimens

Eight beams had been casted with dimension (150)mm width, (250)mm height and (1650)mm length. All beams were reinforced with three (Ø8)mm in top and two (Ø6)mm in bottom ,its fixing bar. To avoid shear failure, (Ø6)mm stirrups with 100mm center to center spacing was used, as shown in plate (3-18). The specimens designation and properties are presented in table (4,5).

Table 4. strength beam and loading

Specimen No.	Compressive Strength (MPa)	Loading type	Applied Load % of Failure Load
Beam 1	32.3	Repeated load	80%
Beam 2	79.2	Repeated load	80%
Beam 3	31.2	Repeated load	80%
Beam 4	71.2	Repeated load	80%
Beam 5	36.6	Repeated load	80%
Beam 6	93	Repeated load	80%
Beam 7	36.2	Repeated load	80%
Beam 8	77	Repeated load	80%

Table 5. details of beams

Specimen No.	Description
Beam 1	Normal strength concrete
Beam 2	High strength concrete
Beam 3	Normal concrete + steel fiber
Beam 4	High strength + steel fiber
Beam 5	Normal concrete + steel fiber + replace LSp by dust of cement CKD
Beam 6	High strength + steel fiber + replace LSp by dust of cement CKD
Beam 7	Normal concrete + MWCNT
Beam 8	Normal concrete + MWCNT

11. Test Results of Test beams .

The results of the test specimens are presented and compared to investigate the significance of the considered parameters. These parameters include, the strength of concrete and the intensity of the applied repeated loads. Eight reinforced concrete beam specimens were tested in two grub that deals with two strength (normal strength 32 , and high strength 79) , two beams were casting with references mix, two beams fiber steel and silica addition to references mix, and two beams were add steel fiber and dust of cement to references mix and two beams were add mule wall carbon Nano tube to references mix . and the results are compared. Eight beams were tested under repeated loading .. The specimens have been grouped in this study according to the concrete and the loading .

The measured data are: the loading and mid span deflection at every second, the first cracking and the ultimate load and their associated mid-span deflection were also measured. Test results were analyzed based on ultimate load, vertical mid span deflection, and failure mode

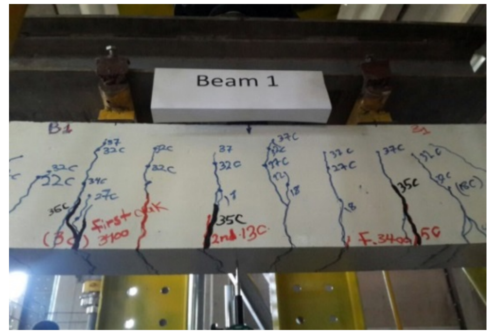

Figure 6. test beam no. 1

The normal strength beam (B1) , the strength of concrete is (32.3 Map) was test under repeated two point load 74 kN (0.8 from load failure), and the first crack appeared at an applied load of (34) kN , After the deflection at first cycle is (4.81) mm, flexural cracks increased , width and depth until failure occurred at (38) cycles , More cracks appeared at mid span between the first crack and failure stages, while more cracks formed in the shear span, then trended to progress towards the load point diagonally (flexural -shear cracks). Finally, the beam failed by widening in the flexural cracks with maximum deflection (7.126) mm under point load .

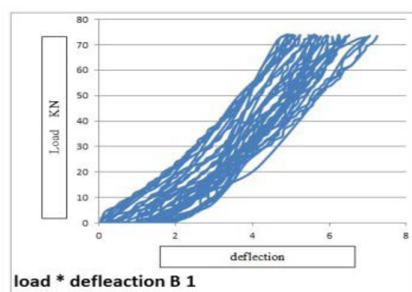

Figure 7. load deflection relationship

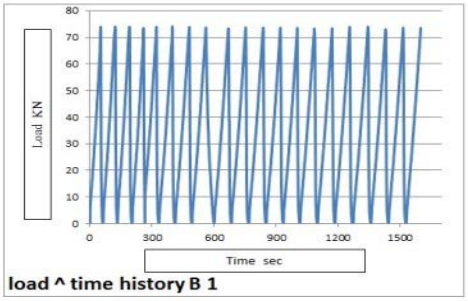

Figure 8. load time history

Table 6. result of test beam

Modeled Beams	Cycles	Modeled Beams	Cycles
Beam (1)	38	Beam (5)	52
Beam (2)	41	Beam (6)	72
Beam (3)	32	Beam (7)	42
Beam (4)	47	Beam (8)	47

12. Conclusions

From the results obtained of this study and discussions, the main conclusions are as follows:

1-The use of steel fiber reinforced beam has significant effect on the flexural behavior of tested specimen under repeated loads. The increase in ultimate load is to found to be about (36.8%) for normal and (70.7%) for high strength
2-The use of Carbon Nano Tube fiber reinforced beam has significant effect on the flexural behavior of tested specimen under repeated loads. The increase in ultimate load is to found to be about (10.5%) for normal and (-4.3%) for high strength
3-The use of dust of cement reinforced beam has significant effect on the flexural behavior of tested specimen under repeated loads. The increase in ultimate load is to found to be about (-8.4%) for normal and (23.4%) for high strength
4-The comparison between the numerical analysis and the experimental results asserted the validity of the numerical analysis and the methodology developed. The maximum difference in the number of cycles is less than 7.4%.
5-The fresh properties of the used SCC fructified in improving the performance of the hardened concrete as it furnishes a homogeneous medium free of lumping and segregation.
6-From numerical analysis results for strengthened test specimens loading, it is found that the failure occurs due to rupture in reinforcing steel.
7- The crack patterns at failure loading stage obtained from numerical analysis agree well with the observed failure made of the experimental tests.

13. Suggestions for Future Work

The following are suggestions for future researches:

1. Studying the behavior of similar beam specimen subjected to repeated loads with higher frequency (1 Hz - 4 Hz).
2. Studying the behavior of similar beam specimen subjected to repeated loads with .0.70% from static load .
3. Studying the behavior of similar beam specimen subjected to static loads
4. Studying the behavior of SCC beam strengthened by CNT by another mix procedure
5. Studying the behavior of SCC beam strengthened by CNT and steel fiber in same beams

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