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Evaluation of Tensile Strength of Concrete with Steel Fiber

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Abstract:- Concrete strength is an important point in the building. Several materials have been used as an addition to the common concrete mix to strengthen it, such as but not limited to crumb rubber, polypropylene fibers, steel fibers, and so on. The size of mixed material will not matter much except for joint construction. Joint construction on reinforced con-crete has a narrow material workspace which makes the size of mixed material matter. This paper will evaluate the strength of steel fiber over a narrow space. From this evalua-tion, we conclude that increasing the number and the length of the wire will rise concrete pull strength but will lower its workability.

Keywords:- *Reinforced Concrete, Joint Construction, Steel fiber.*

I. INTRODUCTION

Earthquake is a common occurrence in places near earth's plate. An earthquake also occurred in place near an active volcano. Building strength plays major point in such event [1]–[9].Not every building has the strength to stand against earthquakes. Some buildings might crack or collapse completely. The stronger there is the less crack it has. Refer-ing to one case earthquake, the building will start to crack from the construction joint[10]. A strong construction joint is needed to strengthen the building against earthquake [11]–[13].

Cracking happens because the pull strength of concrete is relatively low [14]–[18]. Concrete pull strength is only 8% to 15% of its push strength. One way to strengthen this pull strength is by using steel fiber [19]–[21].

This paper will cover the method of strengthening a construction joint using steel fiber. This method is then tested with pull strength stress on multiple test samples to better understand the effect of steel fiber on concrete's pull strength and workability.

II. CONCRETE

This section will cover various terms and materials concerning concrete.

A. Fiber Concrete

Fiber concrete is either normal concrete, lightweight concrete, or high-quality concrete. Steel fiber is added when mixing this concrete to replace the steel beam commonly use on concrete in reinforced concrete.

B. Reinforced Concrete

Steel is placed inside concrete to strengthen-ing it. This method is commonly named reinforced concrete. Reinforced concrete can use steel beam or wire mesh as concrete bone. With this method, the concrete will have higher pull stress durability [3], [22]–[25].

C. Portland Cement

Portland cement is the common requirement to make concrete. Portland works as a bond agent in concrete, binding its content together. Portland cement will harden on reaction with water.

D. Aggregate

Aggregate is used as a concrete filler. By its source, Aggregate can be natural, or artificial. By its size, Aggregate can be soft, or hard.

- *Soft Aggregate.*

Small aggregate with the size around 0.075mm to 5mm. one such is sand. Indonesia have it own standart wich is SK.SNI. S-04-1989 F[26]

- *Hard Aggregate.*

Medium to big aggregate, usually from stone or split stone.

E. Water

Water used to mix concrete must be clean, and must not contain oil, acid, alkali, salts, organic substances or other materials which hazardous to concrete. Drinkable water or processed water for house use should be able to be used.

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F. Concrete Fiber

Dramix steel fiber is used to replace rebar in concrete [27]. Dramix steel fiber have several advantages such as:

1. Increases the strength of concrete, in particular reducing concrete cracking
2. Save time on concrete floor construction
3. Save on construction costs because it is easier to work and the thickness of the concrete can also be thinner

Test Object type	Steel Fiber
I - 0	0
I - 150S	2 cm; 150 grams
I – 150L	5 cm; 150 grams
II - 0	0
II – 300S	2 cm; 300 grams
II - 300L	5 cm; 300 grams
III - 0	0
III – 450S	2 cm; 450 grams
III – 450L	5 cm; 450 grams

Table 1:- Test Object

Test Object type	Volume (cm^3)	Weight (gram)	Density (gram/cm^3)	Density-Rounded (ton/m^3)
I - 0	1727,10	4405	2,55051821	2,55
I - 150S	1727,10	4605	2,666319264	2,67
I – 150L	1727,10	4705	2,72421979	2,72
II - 0	1727,10	4410	2,553413236	2,55
II – 300S	1727,10	4595	2,660529211	2,66
II - 300L	1727,10	4675	2,706849632	2,71
III - 0	1727,10	4405	2,55051821	2,55
III – 450S	1727,10	4755	2,753170054	2,75
III – 450L	1727,10	4740	2,744484975	2,74

Table 2:- Density Test

Fig 1:- Damaged Test Object

III. TEST OBJECT

This section describes our test object and testing.

A. Design

The main objective is to make various test objects with steel fiber as variable.

We make 2 kinds of the test object based on the testing we will do, which is pull strength and density.

Table 1 shows each test subject used. Steel Fiber have 2 variables, which is 2 cm and 5 cm. The amount of Steel Fiber used has 3 variables, which is 150 grams, 300 grams, and 450 grams. There is also a test object without steel fiber which will be used as a comparison.

B. Testing

The test object is tested using pull strength and density. We will use the pressure formula to emulate pull strength and the density formula for density

Test Object type	Weight (gram)	Surface Area (cm^2)	Pull Strength (Kg)	Stress (Kg/cm^2)
0	4405	57	933	16,4
I-150S	4605	57	1082	19,0
II-300S	4595	57	1088	19,1
III-450S	4755	57	1274	22,4

Table 3:- Density Test 2 cm steel fiber

Test Object type	Weight (gram)	Surface Area (cm^2)	Pull Strength (Kg)	Stress (Kg/cm^2)
0	4410	57	933	16,4
I-150L	4705	57	1083	19,0
II-300L	4675	57	1124	19,7
III-450L	4740	57	1444	25,3

Table 4:- Density Test 5 cm steel fiber

Test Object type	Surface Area (cm^2)	Steel Fiber (cm)	Pull Strength (Kg)	Stress (Kg/cm^2)
0	57	-	933	16,4
I-150S	57	2	1082	19,0
I-150L	57	5	1083	19,0

Table 5:- Density Test 150 gram steel fiber

Test Object type	Surface Area (cm^2)	Surface Area (cm^2)	Pull Strength (Kg)	Stress (Kg/cm^2)
0	57	-	933	16,4
II-300S	57	2	1088	19,1
II-300L	57	5	1124	19,7

Table 6:- Density Test 300 gram steel fiber

Test Object type	Surface Area (cm^2)	Surface Area (cm^2)	Pull Strength (Kg)	Stress (Kg/cm^2)
0	57	-	933	16,4
III-450S	57	2	1274	22,4
III-450L	57	5	1444	25,3

Table 7:- Density Test 450 gram steel fiber

IV. RESULTS

We test our test object in sequence. First, we test the density, then the pull strength, for our pull strength will break the test ob-ject hence it can't be used for the density test. Table 2 shows the result of the density test. The weight might less accurate as we use commonly available aggregate without further specific processing. Table 3, Table 4, Table 5, Table 6, and Table 7, shows the result of the Pull Strength Test.

Table 3 shows the impact of 2 cm steel fiber on non-reinforced, 150 gram, 300 gram, and 450 gram reinforced concrete.
Table 4 shows the impact of 5 cm steel fiber on non-reinforced, 150 gram, 300 gram, and 450 gram reinforced concrete.
Table 5 shows the impact of 150 gram steel fiber on non-reinforced, 2 cm, and 5 cm reinforced concrete.
Table 6 shows the impact of 300 gram steel fiber on non-reinforced, 2 cm, and 5 cm reinforced concrete.
Table 7 shows the impact of 450 gram steel fiber on non-reinforced, 2 cm, and 5 cm reinforced concrete.

V. CONCLUSION AND FUTURE WORK

A. *Conclusion*

This paper shows the impact of steel fi-ber on reinforced concrete. We conclude that:

- The addition of steel fiber to the concrete increases the axial tensile strength of the concrete
- The longer the steel fiber in the con-crete affects the axial tensile strength of the concrete.
- The addition of steel fiber to the concrete reduces the workability of the concrete
- The longer the fiber will reduce the workability of the concrete

B. *Future Work*

For the next step, we suggest testing the impact of steel fiber on steel beam rein-forced concretes.

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