



Experimental Testing Comparison between Wiremesh Reinforcement and Plain Reinforcement on Concrete Slabs

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Abstract

The demand for building quality in the construction of structures is a major requirement. One part of the structure is the floor slab work. The main obstacle is when the floor slab is loaded there will be deflection and bending moment. Meanwhile, there are demands for shorter work times at lower costs. This study aims to analyze the concrete slab against the flexural strength test, compressive strength test and tensile strength test of plate reinforcement. In this study, plate reinforcement used plain steel with a diameter of 6 mm and 8 mm. Then the plain iron reinforcement plate was compared with the M6 and M8 wiremesh reinforcement plates. The results showed that the flexural strength test for plain iron reinforcing plates with a diameter of 6 mm was 45000 Kg.cm, while for a concrete slab with wiremesh M6 reinforcement it was 42500 Kg.cm then for reinforcement with a diameter of 8 mm it was 32500 Kg.cm while wiremesh M8 was 57500 Kg.cm. This shows that the concrete slab with wiremesh reinforcement is better able to accept the load, as well as better moment capacity in bending, compressive and tensile tests compared to conventional slabs.

Keywords: Concrete Slabs, Wiremesh Reinforcement, Plain Reinforcement

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INTRODUCTION

With the development of infrastructure development (construction) in various places, technological advances and the latest breakthroughs are required in order to facilitate and support infrastructure development without neglecting its quality and aesthetic value.

Floor plate is one part of the construction work on two-story or more buildings. Floor slabs are basically made using multiplex formwork with reinforcement glued together with wire and then covered with concrete [1]. Along with the development of innovation, wiremesh, half slab and other new breakthroughs have emerged, but have these innovations reviewed the quality aspect?

Looking at several related journals such as "Comparative Analysis of Time, Cost, and Direct Waste of Using Conventional Reinforcement, Wire Mesh, and

Floordeck in Floor Plate Work" which looks at costs, time and direct waste[2]. Then there is also a journal with the title "Study on the Flexural Strength of Ordinary Reinforced Slabs and Wood and Bamboo Reinforced Concrete Slabs on Simple Supports" which discusses comparing the flexural strength of steel-reinforced concrete slabs with wood-reinforced concrete slabs that have equal strength, to determine the increase in slab flexural strength. wood reinforced concrete, if reinforced with bamboo, and to determine the difference in the flexural strength of reinforced concrete slabs by testing with the flexural strength of reinforced concrete slabs by analysis[3].

By looking at several existing journal references and following up on the problems above, the author will conduct a "Bending Strength Test of Wiremesh Plates and Conventional Plates with Reinforcement Diameter 6 and Diameter 8 at $f'c = 19.3 \text{ MPa}$ ", which will be carried out in laboratory of civil engineering university of tribhuwana tunggadewi then the test will be carried out at the university of polytechnic negeri malang. This research is different from the previous journal which discusses the comparison of costs, time and direct waste between reinforced concrete and the other journal which discusses reinforced concrete slabs with different types of reinforcement.

Literature Review

Concrete

Concrete is a material in the form of stone, obtained from making a mixture with a certain proportion of cement, sand, and gravel, and water which makes the mixture hard in the mold according to the dimensions and needs[1].

Concrete has always been the main material for construction work. When we look at construction work, all use concrete as the main material. Concrete is widely used because it is easy to shape according to construction needs, concrete is also very strong against heavy loads and has resistance to high temperatures.

According to [4], [5] that the water-cement factor produces the highest compressive strength almost the same for the cement volume ratio, which is 0.4. The results showed that for the non-sand concrete made from clay bekah aggregate from Cilacap, with a cement aggregate volume ratio of 4:1, the compressive strength of about 15 MPa was obtained. According to [6] the compressive strength of non-sand concrete with gravel from Mount Merapi with a ratio of cement:aggregate volume 1:2, 1:4, 1:6, 1:8, 1:10 is 29.76 MPa, respectively; 20.28 MPa; 16.23 MPa; 8.81 MPa; 5, 26 MPa[7].

Plate

A slab is a flat structural element that has a thickness that is smaller than the other dimensions.

According to [8] defines a plate as a rigid planar structure that is typically made of monolithic material whose height is small compared to other dimensions. The

general load acting on the slab is multidirectional and distributed.

The floor slab is a wide flat area, usually horizontal with the top and bottom surfaces parallel. Floor slabs are usually supported by reinforced concrete girders or beams, by masonry or reinforced concrete masonry walls, by steel structural members directly by columns, or by continuous support to the ground[9]. The functions of floor slabs include: separating parts from the floor, transferring loads on walls, increasing the rigidity of a building, preventing the propagation of sound echoes, insulation against temperature/temperature exchanges. According to [10] that the slab load is borne in both directions by four supporting beams around the panel, thus the slab becomes a slab that flexes in both directions. In analysis, if the ratio between the length and width of the plate is not more than two, then two-way reinforcement is used. If the ratio between the length and width of the plate is more than two, then one-way reinforcement is used [11], [12].

On the floor slab, it is only taken into account the presence of a fixed load (occupants, furniture, weight of the tile layer, self-weight of the plate) which works continuously for a long time. While loads such as earthquake, wind and vibration are not taken into account[13].

Floor slab is a floor that is not located on the ground level, or it can be called a level floor. This floor slab work must be sturdy, rigid, have the same height and be comfortable to stand on.

Flexural Strength

Flexural strength is the ability of a material to withstand bending loads. The value of the tensile stress resulting from the bending moment is divided by the resisting moment of the cross section of the test beam[14]. When a member is loaded with flexural loads, the rods can experience bending, shearing, and deflection. The deflection that occurs in a flexural member can be determined from the external force, the span length, the moment of inertia of the cross section, and the modulus of elasticity[15], [16].

Conventional

method is the assembly of reinforced concrete reinforcement which is carried out on the spot, with formwork using plywood with scaffolding[17]. This is a method that is still considered 'old fashioned' and takes a lot of time and money, so many are competing to get the latest innovations and to get fast time and low costs.

Wiremesh

Wiremesh is a series of high-quality reinforcing steel (with a characteristic yield stress of up to 5,000 kg/cm²) in the form of a net with certain spacing which at each point of contact is connected by electric welding. Wiremesh is the latest breakthrough for reinforced concrete reinforcement using conventional methods. Wiremesh has been scientifically proven to reduce development time[18], [19].

According to [20], the use of geopolymers causes the durability of

the concrete to be maintained so that it has long-term work durability, besides the use of this technology can reduce CO₂ by about 80%. Based on the description that has been conveyed above, it is necessary to have further studies on the application of utilization into concrete panels which in addition to having good durability, have high strength and are also environmentally friendly. Fly ash based wall panels are the latest breakthrough in construction technology. [21] mention the advantages of using geopolymers including high hardness, environmentally friendly, does not produce carbon gas, is resistant to hot temperatures between 600-800°C, is resistant to acidic environments, and does not require heat treatment so that it can be easily used for wide community. [22] conducted a study related to the effect of the compressive strength of geopolymers on the variation of NaOH used. The research material used variations of NaOH 8M, 10M, 12M, 14M, the ratio of Na₂SiO₃/NaOH was maintained 1:1. The test object used a 50x50x50 mm cube with a test age of 28 days. The results obtained the highest compressive strength with the use of 14M NaOH of 60.02 MPa. [23] explained in his research using type C fly ash which contains high calcium oxide, about 8-15% by weight. Calcium oxide plays a role in increasing the setting time to be fast. The compressive strength test was carried out using a 50x50x50mm cube specimen with a concentration of 10 M NaOH, the ratio of sodium silicate: sodium hydroxide was 2, the ratio of alkali:fly ash was 35%, the ratio of paste volume: volume of fine aggregate cavity was 1.5 and alkali to fine aggregate ratio cementitious (A) 0.35. The results showed that the strength at 28-days produced was 53.7MPa.

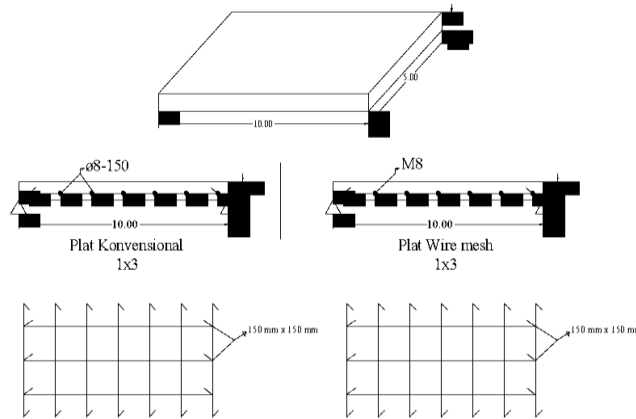
[24] conducted a study on the effect of geopolymer concrete resistance to sulfate. This study used the parameters of NaOH 8M, and 14M, the ratio mass ratio of Na₂SiO₃: NaOH was 0.4 and 2.5, and the mass ratio of alkaline to fly ash was kept constant at 0.35. To evaluate the geopolymer's resistance to sulfate attack, a series of tests were carried out in the form of immersion of the specimen in 5% sodium sulfate for a certain period of time. The results of the tests were carried out after 12 weeks of exposure, there were no significant changes to the compressive strength, mass and length of the test object.

METHOD

Number and Treatment of Test Objects

In this study, 5 pieces of cylindrical concrete were made for compressive strength testing, 8 pieces of iron for tensile strength tests of concrete reinforcement consisting of 4 plain iron reinforcement used as reinforcement using conventional method and 4 pieces of wiremesh reinforcement where the length of each reinforcement is 20 cm, and the flexural strength test of reinforced concrete plates is carried out with 8 specimens consisting of 4 plates with conventional reinforcement and 4 others with wiremesh reinforcement.

Figure 1 Plate Planning Design



RESULTS AND DISCUSSION

Analysis of Plate Compiling Materials

Before loading the plate, it is done first on the concrete sample to determine the strength of the concrete. The concrete test sample uses cylindrical concrete with dimensions of 15 cm in diameter and 30 cm in height. From the results of the compressive strength test of concrete, the average collapse strength when the concrete is crushed with a mixture weight ratio of 1:2:3 (cement:sand:gravel) is 19.3 MPa.

Table 1 Test Results of Compressive Strength of Concrete Samples

Heavy (Kg)	Dim (mm)	Height (mm)	Area (mm ²)	Compressive Load (N)	28 days (Mpa)
12	149	303	17427.78	204500	18.053
12.5	150	300	17662.50	188500	16,419
12.7	150	302	17662.50	222700	19.398
12.1	150	300	17662.50 233500	20.339	12.5
150	300	17662.50 0	295300	25,722	Source

Analysis Results The strength of concrete is highly dependent on the aggregate used, generally the strength of concrete lies in the coarse aggregate and the bond between the coarse aggregates. Where these bonds can close the cavities formed in the concrete. The more coarse aggregate used, the higher the strength of the concrete if it is in accordance with certain limits.

During the concrete treatment period towards the age of 28 days, the environment around the concrete must be considered clean, because if there are chemicals it will affect the quality of the concrete. The curing period of concrete is carried out for 7 days starting from the completion of the concrete being poured into the formwork, curing is done by covering the surface of the plate using a wet sack. After 7 days the wet sacks can be removed and the plate will be tested after that the 7 days test results are converted to 28 days using PBI 1971.

Reinforcement Plates

Engineering tensile tests are mostly carried out to complete basic design information on the strength of a material and as supporting data for material specifications (Dieter, 1987). In the tensile test, the test object is given a continuous increase in the axial tensile force load, at the same time an observation is made on the elongation experienced by the test object. The engineering stress-strain curve was obtained from the measurement of the elongation of the specimen. In long specimens the middle part is usually smaller in cross-sectional area than the two ends. In this study, there were 8 tensile test objects where each sample consisted of 2 test objects. The results of the research can be seen in the following table.

Table 2 Test Results for Tensile Strength of Reinforced Concrete

pmax	py (kN)	kN	Aso (mm²)	yield fy (N/mm²)	stress at breaking stress fu (N/mm²)
M8	16	23.9	41.833	382.48	571.32
M8					
M6	12.25	17.15	25.50	480.30	672.43
M6					
6	11.5	18	28.26	406.94	636.94
6 8					
29.55	19.5	441.6	44.16	669.21	8
Source					

Results The tensile strength test results produce yield stress values f_y and breaking stress f_u where the largest value is found in the tensile strength test results for M6 wiremesh reinforcement with a value of $f_y = 480,30 \text{ N/mm}^2$ and $f_u = 672.43 \text{ N/mm}^2$. The table above shows that both conventional reinforcing steel

and wiremesh reinforcing steel have yield stresses or better known as steel quality or "fy" greater than 240 MPa, so they meet the design standards.

Two-way Plate Bending Strength Test

Figure 3 Image of the Loading Setting on the Plate during Bending Strength Test

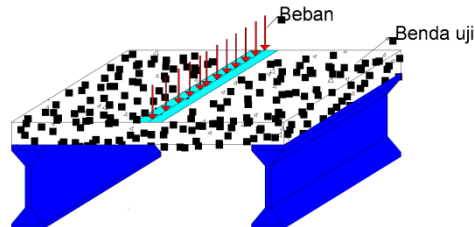


Figure 4 Test Object When Placed on the Test Equipment

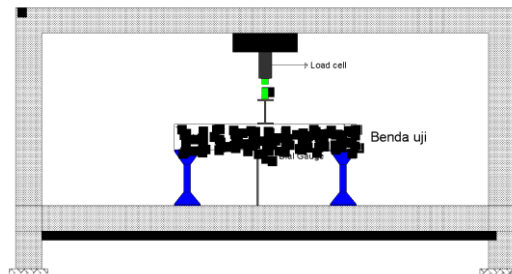


Figure 5 Preparation of the Plate Bending Strength Testing Process



Figure 6 View of the Placement of the Plate on the Test Tool



Figure 7 Reading of the Dial Gauge at the moment Plate in Crisis Cracked Conditions



Figure 3 and Figure 4 illustrate the setting of the plate position at the time of testing where the test object is placed on a pedestal on both sides of equal size, then at the top of the plate is placed iron which divides the 2 sides of the length and width of the plate equally then on the iron The load cell is given a load every multiple of 100 Kg continuously by the load cell until the plate reaches a cracked condition. In every load multiple of 100 Kg, the deflection that occurs will be shown on the dial gauge which is in a position under the plate as shown in Figure 4.

Based on the results of the study, the maximum value of deflection experienced by the concrete and the magnitude of the load that resulted in the deflection of the concrete slab before entering crack crisis.

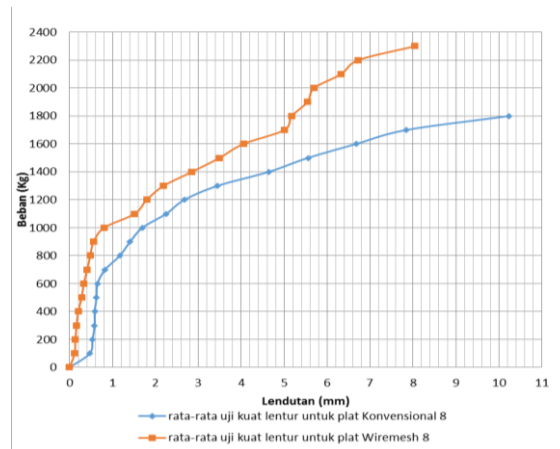
Table 3 Maximum Deflection Value Experienced by Concrete Slabs Due to Loads Given

iron	(Kg)	maximum deflection (mm)
8	1800	10.23
M8	2300	8.045
6	1300	8.1
M6	1700	7.555

Source: Analysis Results

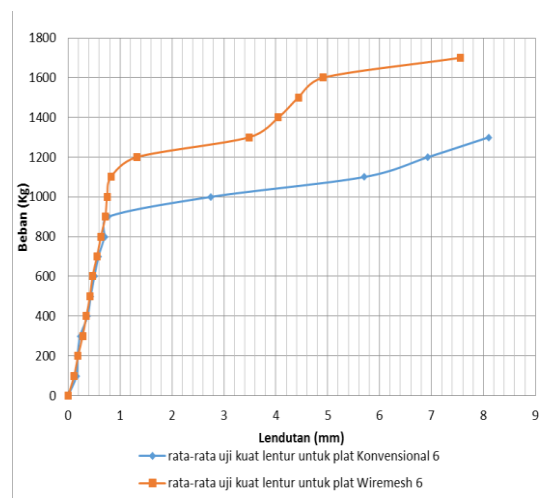
As the results in table 3 which shows the maximum value of deflection experienced by reinforced concrete slabs due to the given load, it can be seen that wiremesh reinforcement is the reinforcement that receives the highest load before entering the crack crisis condition or it can be said that the plate with wiremesh reinforcement is more flexible when receiving a load than the plate with conventional reinforcement.

Figure 8 Comparison Graph of Bending Strength between Conventional Plate and Wiremesh Plate on 8 mm Diameter Reinforcement



The comparison of the results of the flexural strength test for conventional reinforcing plates and wiremesh reinforcement plates with 8 mm diameter reinforcement shows the difference where the plate with wiremesh reinforcement is better able to accept a greater load than the plate with conventional reinforcement.

Figure 9 Graph of Comparison of Bending Strength between Conventional Plate and Wiremesh Plate on Reinforcement Diameter of 6 mm



In the graph shown in Figure 5 and Figure 6 it shows that wiremesh reinforcing steel is easier to bend and able to accept greater loads than plates with conventional reinforcement before reaching a crisis condition. cracked.

The results of the calculation are conventional reinforced concrete slabs and wiremesh reinforced concrete slabs. Based on the results of analytical calculations, the capacity moments and deflections that occur in the reinforced concrete slab above can be seen in table 4.

Table 4 capacity moments and deflections that occur in conventional reinforced concrete slabs and Wiremesh Reinforced Concrete

kode	dim (cm)	P percobaan (Kg)	L (cm)	fy (Kg/cm ²)	fc' (kg/cm ²)	Mmax (Kg.cm)	T=Cc	a (cm)	Mn teori (Kg.cm)	Pteori (Kg)
a1	0.73	2300	100	2400	193	57500	250.996	0.031	1251.14	50.05
b1	0.57	1700	100	2400	193	42500	153.028	0.019	763.71	30.55
c1	0.6	1800	100	2400	193	45000	169.560	0.021	846.05	33.84
d1	0.75	1300	100	2400	193	32500	264.938	0.032	1320.41	52.82

Source: Analysis Results

In table 4 we can see that in theoretical calculations the largest capacity moment is reinforced concrete slab with conventional reinforcement with a diameter of 8 mm with a value of $M_n = 1320.41$ Kg.cm, but during laboratory testing it turned out that the largest capacity moment was found in a wiremesh M8 reinforced concrete slab with a value of $M_{max} = 57500$ Kg .cm.

However, as can be seen in table 4, the analysis results show that the capacity moment of the laboratory test results is greater than the theoretical capacity moment, so it can be said that the four reinforcing bars of the concrete slab above are feasible to use.

CONCLUSION

Based on the results of the tests and calculations carried out, it can be concluded as follows: The value of the tensile strength of reinforcing steel with a diameter of 8 mm at $8 = 441.61$ N/mm² and M8 = 382.48 N/mm² while the value of the tensile strength of reinforcing steel with a diameter of 6 mm at $\emptyset 6 = 406.94$ N/mm² where the iron has met the standard because the tensile strength value is more than planned ($f_y = 240$ MPa). The value of the flexural strength test for reinforced concrete slabs with a diameter of 8 where $8 = 32500$ Kg.cm while M8 = 57500 Kg.cm and on a reinforced concrete slab with a diameter of 6 the flexural strength value is $6 = 45000$ Kg.cm while M6 = 42500 Kg.cm. According to the observations In research, concrete slabs with wiremesh reinforcement show more load-bearing behavior, as well as better moment capacity in bending compared to conventional slabs.

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