Strength and Strength of Lightweight Steel Reinforced Concrete Beam

Iskandar Yasin*, Lilik Hendro Widaryanto, Tori Pebrianto, Irenius Posong, Kamaludin

Department Civil Engineering, University Sarjanawiyata Tamansiswa
**Corresponding author: iskandaryasin@ustjogja.ac.id*

ABSTRACT

In the world of construction, reinforced concrete beams use longitudinal reinforcement in order to withstand the tensile stress that occurs in the cross section of the concrete beam and the longitudinal reinforcement used is steel reinforcement (rebar reinforcemen). Tensile stresses reaching 420 MPa are the main reason for reinforcing steel used in reinforced concrete beams, however, due to technological developments, there are materials that have tensile stresses that exceed reinforcing steel, namely mild steel. mild steel is light cold rolled steel with high quality which is light and thin, but has a tensile stress that exceeds ordinary reinforcing steel, which is 550 MPa, so in this study we will use mild steel reinforcement for C channel and U channel as reinforcement. concrete block structure. The purpose of this study was to determine the difference between the flexural strength of concrete beams using mild steel and concrete beams using steel reinforcement and to calculate the stiffness value. This research was carried out through several stages, namely: procurement of materials and equipment, inspection of materials and equipment, planning of concrete mixes, concrete manufacture, concrete treatment (curing), concrete testing and analysis of research results. from samples with 2 comparisons that have been tested, the average flexural strength value in 3 samples of reinforced concrete beams with mild steel reinforcement is 391.96 kg/cm² U channel and the average flexural strength value from 3 samples of C channel is 385, 44 kg/cm² and for the average value of the shear strength test results from 4 U channel specimens is 66.28 kg/cm².

***Keywords**: concrete beams, mild steel, strength and stiffness*

1. INTRODUCTION

Concrete is an important element, especially its use as a form of structure that is often used in society, with the development of technology today we can create buildings that have advantages and advantages. Where concrete has advantages, among others, is easy to shape as needed, has a high compressive strength, is resistant to rust or decay by the state of the area, is resistant to weather (hot and cold). Concrete also has several weaknesses, including weak to tensile forces, expands and shrinks when there is a change in temperature, is difficult to waterproof perfectly and is brittle.

Reinforced concrete as a beam element is usually given flexible longitudinal reinforcement and shear stirrup reinforcement. Concrete also has several weaknesses, namely weak against tensile strength, expands and shrinks when changes in temperature, difficult to air tight perfect and brittle[1]. Flexural reinforcement to withstand bending loads that occur in the beam. On the other hand shear reinforcement to withstand shear forces. Beams are a building structure that serves to support the floor above the beam also acts as a channel for the moment leading to the columns. Blocks are also known as elements bending structure, so that the beam is more dominant holding style in shape bending moment and shear[2]. Concrete and steel are two types of structural materials that are commonly used in the construction of a building. the two types of material before each other help each other, but can also stand alone, so that many structures with a uniform shape and function can be formed with concrete or steel, concrete is a material that is relatively strong against compressive loads but weak against tensile loads. . To obtain a building structure that is relatively strong against tensile loads, the addition of a beam is also known as a flexural structural element, so that the beam is more dominant in resisting forces in the form of bending and shear moments.

Mild steel material is a steel profile that is formed in such a way through the cooling process of a steel plate that has high quality that is light and thin, with a thickness ranging from 0.4 mm - 6.4 mm, although it is included in the thin category, it has structural credibility that is close to conventional steel. Based on the National Standard (BSN 4906, 2007), the mechanical properties of mild steel with G550 quality have a minimum tensile strength of 550 Mpa equivalent to conventional steel quality BjTS 550 which has a minimum tensile strength of 687.5 Mpa and a minimum yield strength of 550 Mpa. Mild steel profiles are used common in the manufacture of house roof frames as material for the horses. Although in its development a lot of mild steel experience good innovation treatment, and make efficient on some jobs such as frame making, making wall partitions, you can even used as pillar or frame/column of a building[3]. The use of mild steel as a substitute for conventional reinforcement in the beam is expected to reduce the structural load on the beam element but still be able to withstand the load on it, which in turn can reduce the impact of the load. The development of light steel in the world of building construction was investigated in 1939 by Prof. George Winter of Cornell University. In 1949 the research was supported by AISI (American Iron and Steel Institute) and was written in the form of a design code so that the use of mild steel was increasingly developed as building construction, such as floor beams, industrial or commercial frames.

Several developed countries other than America, such as Australia and England, have also made design codes regarding the use of mild steel in building construction, such as the Australian Standard (AS/AZS), British Standard and Eurocode. This affects the widespread use of mild steel as a construction material.

Beams are also known as flexural structural elements, so that beams are more dominant in resisting forces in the form of bending and shear moments. In this study, we will use mild steel profiles of C channel and U channel as a replacement element for retaining tensile forces in the concrete beam structure where the flexural strength and shear strength are tested which is planned to remain strong and able to withstand the load carried. Concrete is a Portland cement mix or other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without additives. Common aggregate types grouping is fine aggregate and coarse aggregate[4].

LITERATURE REVIEW

Test Object Material

1. Portland cement is a material that functions as a hydraulic binder mixture that will harden when mixed with water, used as the main ingredient between a mixture of water and a mixture of both fine and coarse aggregates. Cement can be seen in Figure 1 below:

Gambar 1 : semen Portland

2. Fine aggregate is fine mineral grains or sand that comes from natural processes or comes from the stone crusher industry, this aggregate is sand that passes a 0.5 cm sieve taken from Mount Merapi which will later be used for site mix concrete, river stone foundations, and plastering of beams and columns. Fine aggregates can be seen in Figure 2 below:

Gamabar 2 : agregat halus

3. Coarse aggregate used in the project is in the form of split stone or split stone which is used for the manufacture of site mix concrete. This coarse aggregate has sizes 1, 1.5, and 2.3 in centimeters taken from Mount Merapi. Coarse aggregate can be seen in Figure 3 below:

Gambar 3 : coarse aggregate

4. Gravel is a small rock, usually crushed granite. The size of the gravel that is always used is between 2 mm and 75 mm, which can be seen in Figure 4 below:

Gambar 4 : kerikil (gravel)

5. Water used for concrete mixtures must meet the following provisions. If the quality is doubtful, it must be chemically analyzed and its quality evaluated according to its intended use. It must be clean, not

containing mud, oil and other floating objects, which can be seen visually. Water can be seen in Figure 5 below:

Gambar 5 : water

6. Mild steel is carbon steel that is rigid and strong so it is widely used for construction purposes. Like the construction of the roof truss. With the properties of mild steel above, we conducted experimental research to find the value of strength and stiffness in mild steel reinforced beams.

Gambar 6 : light steel

7. Playwood is factory-produced plywood that functions as a formwork material. Because the surface is smooth, it is used as a formwork material to get a good concrete surface. The thickness used in the field is 12 mm. playwood can be seen in the image below:

Gambar 7 : playwood

8. Portland cement is a material that functions as a hydraulic binder mixture that will harden when mixed with water, used as the main ingredient between a mixture of water and a mixture of both fine and coarse aggregates. Cement can be seen in Figure 1 below:

Gambar 1 : semen Portland

9. Fine aggregate is fine mineral grains or sand that comes from natural processes or comes from the stone crusher industry, this aggregate is sand that passes a 0.5 cm sieve taken from Mount Merapi which will later be used for site mix concrete, river stone foundations, and plastering of beams and columns. Fine aggregates can be seen in Figure 2 below:

Gamabar 2 : agregat halus

10. Coarse aggregate used in the project is in the form of split stone or split stone which is used for the manufacture of site mix concrete. This coarse aggregate has sizes 1, 1.5, and 2.3 in centimeters taken from Mount Merapi. Coarse aggregate can be seen in Figure 3 below:

Gambar 3 : coarse aggregate

11. Gravel is a small rock, usually crushed granite. The size of the gravel that is always used is between 2 mm and 75 mm, which can be seen in Figure 4 below:

Gambar 4 : kerikil (gravel)

12. Water used for concrete mixtures must meet the following provisions. If the quality is doubtful, it must be chemically analyzed and its quality evaluated according to its intended use. It must be clean, not containing mud, oil and other floating objects, which can be seen visually. Water can be seen in Figure 5 below:

Gambar 5 : water

13. Mild steel is carbon steel that is rigid and strong so it is widely used for construction purposes. Like the construction of the roof truss. With the properties of mild steel above, we conducted experimental research to find the value of strength and stiffness in mild steel reinforced beams.

Gambar 6 : light steel

14. Playwood is factory-produced plywood that functions as a formwork material. Because the surface is smooth, it is used as a formwork material to get a good concrete surface. The thickness used in the field is 12 mm. playwood can be seen in the image below:

Gambar 7 : playwood

Test Object Making

In carrying out the manufacture of test objects, the first step that must be done is to prepare tools and materials, then make the size of the beam formwork frame that has been determined, then adjust and seal the formwork until it is really tight (straight and neat).

Gambar 8 : make size on formwork material

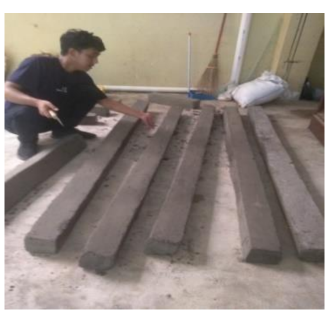
Gambar 9 : set and close the formwork

Next, make the concrete mix according to the plan, first pour the sand, gravel, cement and sufficient water into the concrete mixer, wait until evenly distributed, then pour the liquid concrete into the prepared formwork. It can be seen in the image below.

Gambar 10 : liquid concrete manufacture

Gambar 11 : test object casting

Then the dismantling of the formwork is carried out when the concrete is old enough and the concrete is treated for 28 days, the concrete treatment is carried out when the concrete has begun to harden. Then the concrete blocks are ready to be tested. It can be seen in the image below.



Gambar 12 : formwork demolition

Gambar 13 : maintenance of the test object for 28 days

In the implementation of testing the test object, the first step is to prepare the test object, give a code number for each test object to facilitate data collection, measure the cross section of the beam carefully and weigh the test object.

Gambar 14 : prepare test object

Gambar 15 : weighing test object

Then place the beam on the test apparatus and then record the maximum load that breaks the beam.

Gambar 16 : prepare the test object on the test equipment

Gambar 17 : ttest object compressive strength

Concrete mix for test objects must be taken directly from the mixer using a bucket or other tool that does not absorb water. If it is considered necessary to mix again before being filled into the mold for making the test object, it can be seen in the picture.

Test Object Care

Concrete treatment is carried out when the concrete has begun to harden which aims to keep the concrete from losing water quickly and as an action to maintain the humidity / temperature of the concrete so that the concrete can achieve the desired concrete quality. Treatment can be seen in the image below:

Gambar 18 : test object maintenance

2. METODHOLOGY

Slump Test

The concrete slump test is a test that is carried out to find out how thick the concrete mix will be. The concrete slump test is a test of the viscosity of fresh concrete so that the concrete produced can achieve the strength of the concrete quality and get the best concrete slump value. The slump test can be seen in the picture below this :

Gambar 19 : slump test

Test Object Test

The following is a beam test using a one-point loading method in the middle of the test object and supported at the ends of the test object. The loading uses a Hydraulic Compression Testing Machine to determine the maximum strength limit of mild steel reinforced beams.

Test Object Material

3. RESULT AND DISSCUSION

Beam Shear Strength Test

The following are the results and discussion of the frictional strength testing of reinforced beams with mild steel reinforcement as follows. Mix design mix the ratio of 1 cement, 2 sand, 3 gravel To get 1 m^3 of concrete, the volume ratio is as follows:

Material specific gravity

- Cement = 3100 kg/m3
- Sand = 2600 kg/m3
- Coarse aggregate = 2600 kg/m3
- Water = 1000 kg/m3

Specific gravity of fresh concrete : 2325 kg/m3 (average density of materials) daily volume of material per-1m3 of concrete :

- Cement : 1/6,5 = 0,15 m3
- Sand : 2/6,5 = 0,31 m3
- Coarse Aggregate : 3/6,5 = 0,46 m3
- Water : 0/5 = 0,08 m3

Weight of each material needed per-1m3 of concrete:

- Cement : 0,15 m3 x 2325 kg/ m3 (density of fresh concrete) = 358 kg
- Sand : 0,31 m3 x 2325 kg/m3 (density of fresh concrete) = 715 kg
- Coarse Aggregate : 0,46 m3 x2325 kg/m3 (density of fresh concrete) = 1073 kg
- Water : 0,08 m3 x 2325 kg/m3 (density of fresh concrete) = 179 kg

First of all we have to know the weight of the concrete, here the specific gravity of the concrete is 2,325 kg/m3. then just calculate the weight of each to make the concrete mix. the following table of calculations.

Table 1 Calculation

Materials	Volume		Density of Concrete	amount
Cement	1:6,5	X	2.325 kg/m3	358 kg
Sand	2:6,5	X	2.325 kg/m3	715 kg
Gravel	3:6,5	X	2.325 kg/m3	1073 kg

Table 2 : test result

No	Benda Uji	Tanggal Dibuat	Tanggal Diuji	Umur	Bentang	Lebar	Tinggi	Berat	Berat Vol	Beban	Kuat geser	Rata-rata	Keterangan
				Hari	Mm	Mm	mm	kg	Kg/m³	kn	Kg/cm²	Kg/cm²	
1	Balok	18/11/2021	17/12/2021	29	400	100	100	1,160	2232	15	61,18	66,28	Patah Tengah
2		18/11/2021	17/12/2021	29	400	100	100	9,945	1989	20	81,57		Patah Tengah
3		18/11/2021	17/12/2021	29	400	100	100	10,765	213	15	61,18		Patah Tengah
4		18/11/2021	17/12/2021	29	400	100	100	10,695	2139	15	61,18		Patah Tengah

In carrying out the research, the results obtained from the relationship of shear strength to reinforced concrete beams. This is done after the age of the concrete reaches 29 days. With an average value of 4 (four) test objects, namely 66.28 kg/cm2.

The following are the dimensions of the beam used at the time of the study as follows, it can be seen in Figure 11 below:

Gambar 20 : beam look

Description of beam dimensions:
Length : 50 cm
Width : 10 cm
High : 10 cm

Beam Bending Strength Test

Mix Design calculation is the value for carrying out a test object obtained from the results of testing in the Laboratory of the Tamansiswa Bachelor's University. Mix Design Calculation with SNI.T-7656-2012 Method

a. Cement : 118,84 kg
b. Fine aggregate : 426,61 kg
c. Coarse aggregate : 324,83 kg
d. Water : 91,81 liter
Amount : 962,09 kg/m³

For molded concrete needs 0,0200 m³

a. Cement = 118,84 x 0,0200
= 2,376 kg
b. Fine aggregate = 426,61 x 0.0200
= 8,531 kg
c. Coarse aggregate = 324,83 x 0,0200

= 6,496 kg

d. Water = 91,81 x 0,0200

= 1,836 liter

Examination of the physical properties of aggregate

In this study, tests were carried out to determine the physical properties of the aggregates used in the process of making the specimens.

- **Fine aggregate**

Sand Moisture Content

- Initial weight (B1) = 100.00 gram
- Final weight (B2) = 97.98 gram

Water level

Conclusion $= \frac{B1-B2}{B1} x100\%$

$= \frac{100.00-97.98}{97.98} x100\%$

= 2.0 %

Sand Moisture Content (*Sature Surface Dry / SSD*)

- Initial weight (B1) = 100.00 gram
- Final weight (B2) = 97.47 gram
- Water level SSD $= \frac{B1-B2}{B1} x100\%$

$= \frac{100.00-97.47}{97.47} x100\%$

= 2.8 %

Sand Density

The test results and calculation results from the data that have been collected, in order to find the value of the specific gravity of Merapi sand.

Tabel 3 : sand density check

NO	Checking type	Amount
1	Weight of test object (W)	30 gram
2	Initial water volume (V_o)	50 ml
3	The volume of water after adding the test object (V_3)	66 ml
4	Water volume increase (V_2) = V_3 - V_o	13 ml

Specific gravity $= \frac{w}{V2}$

$= \frac{3}{1}$

= 2.307

In this study, the weight of Merapi sand was obtained 2.307.

Fine Aggregate Sludge Content

Below are the results of testing the silt content on the fine aggregate of Merapi sand:

Initial weight (B1) = 100.01 gram

Final Weight (B2) = 97.52 gram

Sludge levels $= \frac{B1-B2}{B2} x100\%$

$= \frac{100.01-97.52}{97.52} x100\%$

= 2.48 %

Fine Aggregate Gradation

In this study, a sand gradation test was carried out which was used to determine the characteristics of the grains based on the fine aggregate gradation group and was used to determine the fine modulus of the grains, the test
data were as follows.

Table 4 : Gradation test results

Ukuran Saringan		Berat Tertahan	Kumulatif			Spesifikasi
No	Mm	(gram)	Berat Tertahan	% Tertahan	% Lolos	
3/8	9,5	1,28	1,28	0,13	99,87	100 - 100
4	4,76	22,11	23,39	2,34	97,66	90 - 100
8	2,38	53,9	77,29	7,73	92,27	75 - 100
16	1,19	200,69	277,98	27,79	72,21	55 - 90
30	0,59	167,79	445,77	44,56	55,44	35 - 59
50	0,279	305,62	751,39	75,12	24,88	8 - 30
100	0,149	151,41	902,8	90,25	9,75	0 - 10
Pan		97,22	1000,02			Daerah II
Jumlah		1000,02		247,92		

Coarse Aggregate Test Results

It is planned that the specific gravity of the coarse aggregate in this study, the coarse aggregate used is Merapi stone taken from Stone Crusher PT. The form of Bhakti Crushindo in the Manisrenggo Klaten area. Below is a table of the results of testing the specific gravity of Merapi stone aggregates.

Table 5: Merapi stone specific gravity test

NO	Checking type	Amount
1	Weight of test object (W)	35.63 gram
2	Initial water volume (V_0)	50 ml
3	Volume of water after adding the test object (V_3)	65 ml
4	Volume of water rise (V_2) = V_3 - V_0	15 ml

Specific gravity $= \frac{W}{V2}$

$= \frac{35.63}{15}$

= 2.376

Coarse Aggregate Moisture Content

Merapi water content (actually)

Initial weight (B1) = 103.95 gram

Final weight (B2) = 103.28 gram

Water content (actually) $= \frac{B1 - B2}{B2} x\ 100\%$

$= \frac{103.95 - 103.28}{103.28} x\ 100\%$

= 0.65%

Merapi stone water content (SSD/*Sature Surface Dry*)

Initial weight (B1) = 100.93 gram

Final weight (B2) = 100.13 gram

Water content SSD $= \frac{B1 - B2}{B2} x\ 100\%$

$= \frac{100.93 - 100.13}{100.13} x\ 100\%$

= 0.79 %

Water Absorption

Oven dry weight (A) = 100,41 gram

Weight dry condition surface (B) = 97.76 gram

Water Absorption (Sw) $= \frac{S-A}{A} x100\%$

$= \frac{100.41-97.76}{97.76} x100\%$

= 2.7 %

For the results of fine aggregates, see the table below.

Table 6: fine aggregate test results

NO	Fine Aggregate Test	Result
1	Fine aggregate volume weight	1,307 gram
2	Fine aggregate slurry content	2,48 %
3	Fine aggregate moisture content	2,80 %
4	Absorption	2,70 %

For Coarse Aggregate Testing Results can be seen in the table below.

Table 7: test results of coarse aggregate

NO	Coarse Aggregate Test	Result
1	Coarse aggregate volume weight	2,376 gram
2	Coarse aggregate slurry content	0,65 %
3	Coarse aggregate moisture content	0,89 %
4	Absorption	2,70 %

Slump Test
From the slump test of ready mix concrete obtained from the foundry concrete business, the slump results are 7 cm.
The slump measurement is carried out with reference to the rules set out in 2 standard rules:

- PBI 1971 NI 2 (Indonesian Reinforced Concrete Regulations)
- SNI 1972 – 2008 (How to Test Concrete Slump)

Figure 21 : *slump test*

Flexural strength of concrete blocks aged 28 days
The results of the flexural strength test can be seen in the image below:

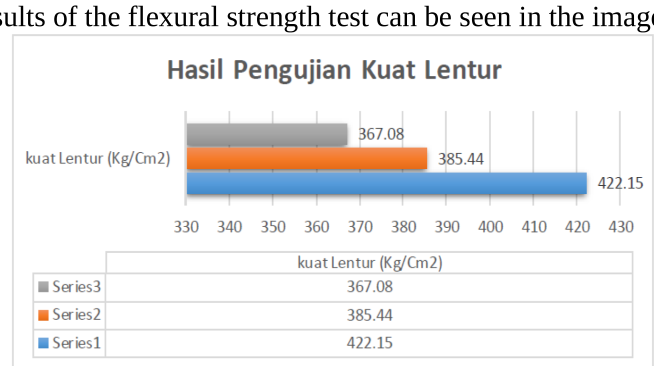


Figure 22 : flexural strength diagram of concrete blocks

Information :
B1 = first test beam
B2 = second test beam
B3 = third test beam
Based on Figure 22, the flexural strength of the concrete beam reaches a maximum load of 23.0 kN in sample B1, in sample B2 the maximum load is 21.0 kN and in sample B3 the maximum load is 20.0 kN.

Calculation of flexural strength of concrete block

Below shows the test results and calculation results when the flexural strength of the concrete beam can be seen in the table below.

Table 8: test results of concrete blocks

Sampel	Ukuran Benda Uji			Beban maksimum (KN)	Kuat Lentur (Kg/Cm2)	Rata-Rata (Kg/Cm2)
	P	L	T			
B1	200	10	10	23	422,15	
B2	200	10	10	21	385,44	391,96
B3	200	10	10	20	267,08	

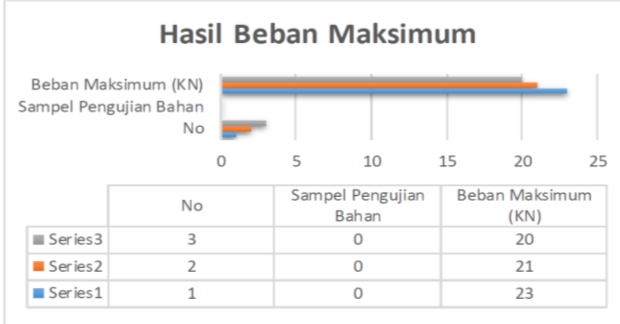


Figure 23 : calculation of flexural strength

Information :
B1 = first test beam
B2 = second test beam
B3 = third test beam
From Figure 13 above, it can be seen that the ratio of the reinforced concrete beams to the average beam value is 391.56 kN.

Beam Bending Strength Test

Design mix calculation

The Mix Design calculation is the value for carrying out a test object obtained from the results of testing in the Laboratory of the Tamansiswa Bachelor's University. Mix Design Calculation with Method 1: 2: 3, K225 (fc=18.68 mpa)

a. Cement: 1 kg
b. Fine Aggregate : 2 kg
c. Coarse Aggregate : 3 kg
d. Water : 0.5 kg

Total : 6,05 kg/m³

For molded concrete needs 0,02 m³ = 20 kg/m³

a. Cement = (1/6,5) x 20 kg/m³
= 3,1 kg
b. Fine Aggregate = (2/6,5) x 20 kg/m³
= 6,2 kg
c. Coarse Aggregate = (3/6,5) x 20 kg/m³
= 9,2 kg
d. Water = (3/6,5) x 20 kg/m³
= 1,5 liter

Fine Aggregate Testing can be seen in the table below.

Table 9 : fine aggregate test

NO	FINE AGGREGATE TESTING	Result
1	Fine aggregate volume weight	2,03 gram
2	Fine aggregate slurry content	3,27 %
3	Fine aggregate moisture content	2,94 %
4	Absorption	3,71 %

Coarse Aggregate Testing can be seen in the table below.

Table 10: Coarse Aggregate Test

NO	Coarse Aggregate Test	Result
1	Coarse aggregate volume weight	2,37 gram
2	Coarse aggregate slurry content	0,65 %
3	Coarse aggregate moisture content	0,89 %
4	Absorption	2,70 %

Bending Strength of Concrete Beams Aged 28 Days The results of the flexural strength test can be seen in the graph below.

Figure 24 : flexural strength chart of concrete blocks

Based on the graph above, the flexural strength of the concrete beam reaches a maximum load of 20.0 KN in sample B1 and in samples B2 and B3 the maximum load is 21.5 KN.

Calculation of Bending Strength of Concrete Beams

To clarify the table for calculating the flexural strength of concrete beams with mild steel reinforcement C channel can be seen in the table below.

Table 11 : Calculation of flexural strength of concrete blocks

Sampel	Ukuran Benda Uji			Beban (KN)	Kuat Lentur (Kg/Cm2)	Kuat Lentur (Mpa)	Rata-rata
	P	L	T				
B1	200	10	10	20	367,08	35,99	385,44
B2	200	10	10	21,5	394,62	38,69	
B3	200	10	10	21,5	394,62	38,69	

Figure 25 : flexural strength calculation graph

From the graph above, it can be seen the ratio of reinforced concrete beams with an average beam value of 385.44 KN.

IDENTIFICATION OF PROBLEMS

At this time the business world is entering the era of globalization where all parties are competing to create technology that facilitates human survival as well as the development of mild steel material which is currently the prima donna in the community because it is easier to obtain and affordable prices, but in Indonesia the use of mild steel material In general, it is better known as a roof truss and has not been popularly used as reinforcing steel for concrete beams. Therefore, it is necessary to conduct further research on mild steel material as reinforcement for concrete beams. because of this research it is expected that the use of mild steel is not only applied as a roof truss but is used as reinforcement in other structures.

DESTINATION

The purpose of this research that the authors do include:

• Knowing the average value of shear strength of reinforced beams with U . channel mild steel reinforcement

• to determine the maximum load that can be received by a concrete beam with mild steel reinforcement U . channel

• to determine the maximum load that can be received by a concrete beam with mild steel reinforcement C . channel

• To determine the effect of using mild steel as reinforcement in reinforced concrete beams on the mechanical properties of concrete beams.

METHODOLOGY

This research was conducted using experimental methods and laboratory tests with the aim of knowing the flexural strength of reinforced concrete beams with mild steel reinforcement. The implementation time is from November to December 2021 at the Integrated Laboratory of the Bachelorwiyata Tamansiswa University which is located on Jl. Raya Mendut, Wiragunan, Mergangsang, Yogyakarta. The parameters carried out are material characteristics test, and the compressive strength test for concrete blocks is carried out at the Aneka Dharma Persada Laboratory (ADP) on Jl. Wates KM 12 Dusun Bandut Lor, Argorejo, Sedayu, Bantul, Yogyakarta.

In the research, several stages of work from material preparation, material inspection, mixture planning were continued with the manufacture of test objects and testing of test objects. All work is guided by applicable regulations/standards with adjustments to existing laboratory conditions and facilities. The research flow chart can be seen in the image below.

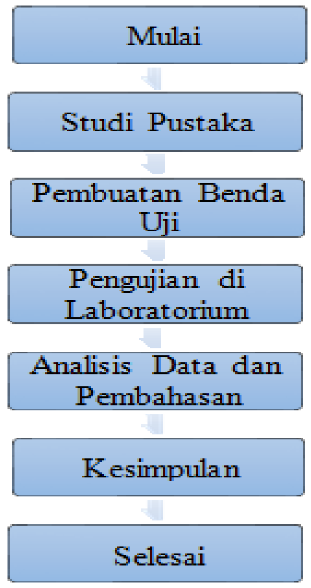


Figure 26 : Research Flowchart

As for in this discussion, there are two types of test objects that will be tested, the first is a concrete beam with dimensions of 200 cm x 10 cm x 10 cm which will be used to find the value of flexural strength and the second is a concrete beam with dimensions of 40 cm x 10 cm x 10 cm. which is used to find the value of shear strength, which later can be concluded the strength and stiffness of the lightweight steel reinforced concrete beam. The dimensions of the test object can be seen in table 12 and table 13 below:

Table 12: dimensions of the first object

Block Type	Test Object Code	Dimensions (cm)	Number of Test Items
Flexible concrete beam	BKL	10 x 10 x 200	3

Figure 27: the type of the first test object

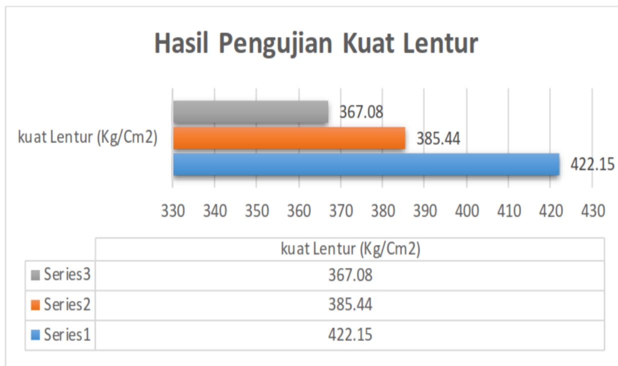
Table 13: The dimensions of the second object

Block Type	Test Object Code	Dimensions (cm)	Number of Test Items
Flexible concrete beam	BKG	10 x 10 x 40	4

Figure 28: the second type of test object

DISCUSSION

Testing the Bending Strength of 28 Days Concrete Blocks



Gambar 29 : grafik hasil kuat lentur

Information :
B1 = First test block
B2 = Second test block
B3 = Third test block
Based on graph 5.15 shows the value of the flexural strength of the concrete beam reaches a maximum load of 23.0 KN in sample B1.
In sample B2 the maximum load is 21.0 KN and in sample B3 the maximum load is 20.0 KN.

Calculation of flexural strength of concrete blocks
The following shows the test results and the results of calculating the flexural strength of concrete beams, which can be seen in table 14 below.

Table 14: test results of flexural strength of concrete blocks

Sampel	Ukuran Benda Uji			Beban maksimum (KN)	Kuat Lentur (Kg/Cm2)	Rata-Rata (Kg/Cm2)
	P	L	T			
B1	200	10	10	23	422,15	391,96
B2	200	10	10	21	385,44	
B3	200	10	10	20	267,08	

From table 14 above, it can be seen the ratio of reinforced concrete beams with an average beam value of 391.96 kg/cm². And the flexural strength of sample B1 has a value of 422.15, B2 385.44 and B3 267.08 which each sample has a value that is quite different.

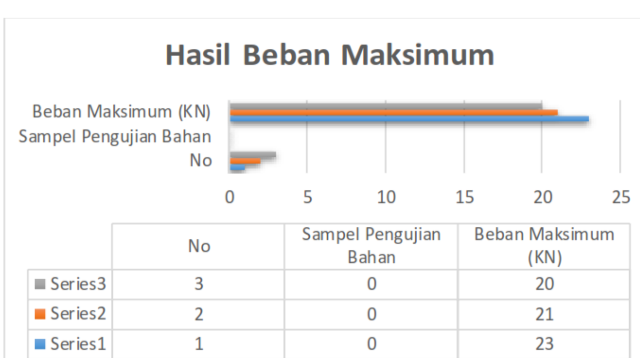


Figure 30: flexural strength calculation graph

The graph above explains that each sample has a different maximum load. Sample 1 has a value of 23 kN, sample 2 has a value of 21 kN and sample 3 has a value of 20.

Can be seen the damage to the concrete beams during testing in Figure 31.

Figure 31 : damage to concrete blocks after testing

Based on Figure 31 at the time of testing, it can be seen that the crack occurred in the middle after that it propagated to the right and left sides.

4. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the research above, it can be concluded

• the average value of the shear strength test results from the test object is 66.28 kg/cm². where the shear strength for specimens B1, B2, B3 and B4 are 61.18 kg/cm², 81.57 kg/cm², 61.18 kg/cm² and 61.18 kg/cm², respectively.

• the maximum load for specimens B1, B2 and B3 is 23 kN, 21 kN and 20 kN, respectively.

• From the results of the flexural strength testing that has been carried out, it can be seen that the B1 concrete beam using mild steel channel C has a load value of 20.0 KN and a flexural strength value of 367.08 Kg/cm², while for concrete beams B2 and B3, it has the highest value (maximum load) with a load value of 21.5 KN and a flexural strength value of 394.62 kg/cm². and has an average flexural strength of 385.44 kg/cm².

Suggestion

• For the manufacture of molds, it is better to use thick materials, so that the results are as neat as expected

REFERENCES

[1] A. Suandi, "Analisa Kuat Lentur Balok Beton Bertulang dengan Menggunakan Profil Baja Ringan Tulangan," 2020.

[2] M. S. Muslimin and A. P. Putri, "Uji lentur balok beton bertulang baja ringan dengan skema tulangan tunggal," vol. 11, n, pp. 171–180, 2021.

[3] A. H. Tumcala, "Tinjauan Kinerja Balok Beton Bertulang Tampang Empat Persegi Panjang dengan Tulangan dari Profil Baja Ringan," 2017.

[4] Wibisono, "Penambahan Perkuatan Lentur Balok Beton Bertulang dengan Penambahan Pelat Baja," 2017.