International Journal of Engineering and Science Applications
ISSN 2406-9833 Vol 7 No. 1

IJEScA

DUCTILITY OF COUPLING BEAM USING BENDRAT FIBER SUBJECTED TO LATERAL CYCLIC LOAD

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ABSTRACT

The design of the concrete structure, the tensile stress that occurs is held by reinforcing steel, while the tensile concrete is not calculated to withstand the tensile stresses that occur because the concrete will soon crack if it gets tensile stress that exceeds the tensile strength. Earthquake is one of the major problems facing Indonesia. should have sufficient strength and ductility to be able to accommodate earthquakes that occur. The purpose of this study was to analyze the ductality value of column beam relationships in the joints due to cyclic loads. The method used in this study is an experimental study method. For the length of the coupling beam the same is maintained for the whole coupling beam of 115 cm so that the beam height is calculated based on the length and the ratio of length to height, 40 cm for each specimen. The results of the study showed that the normal coupling beam component had a ductility of 3.86 while the coupling beam component which had fiber with a 40 cm joint length had a ductality value of 4.01. It was concluded that the structural performance levels of both normal and fiber coupling beam components with a length and height of 40 cm and 40 cm coupling beam models based on SNI - 1726 - 2002 were at the level of partial ductility

Keywords: Ductility, notch connection, beam-column correlation

1.INTRODUCTION

Background In designing a concrete structure, the tensile stress that occurs is held by reinforcing steel, while tensile concrete is not calculated to withstand tensile stresses that occur because the concrete will crack immediately if it gets tensile stress that exceeds tensile strength. In terms of structural durability, these cracks will result in corrosion of reinforcing steel so that it will reduce the area of the reinforced steel, although the review of this crack structure has not been dangerous [1]. This means that it is a waste, because in reality the concrete area of attraction really exists and must also be carried out. One way is to add fiber to the concrete mixture so that the cracks that might occur due to tensile stress in the tensile concrete area will be retained by these additional fibers, so that the tensile strength of the fiber concrete can be higher than the tensile strength of ordinary concrete. Besides that the main problem in high quality concrete is that with increasing stiffness, the strength of the concrete will also increase. The greater the compressive strength of the concrete, the concrete has a low ductility. The inverse relationship between strength and ductility is a serious problem when using high-quality concrete. To overcome the problem of these two ingredients, short fiber can be added. Addition of fiber can overcome the problem of concrete ductility. Steel fibers can increase greater energy absorption and also in terms of concrete ductility. [2, 3]

The benefit of this study is to evaluate the ductility of the coupling beam connection between beam joints due to cyclic load. In carrying out this research the aim to be achieved is to analyze the ductility value of the coupling beam connection at the connection due to cyclic load

A. Literature Review

This study aims to test the compressive strength of paving blocks with the addition of fiber (palm fiber, plastic and wire). The quality of the compressive strength of the paving block mixture is K300 by optimizing the use of fiber as a mixture additive

The results of the study were obtained: Based on the results of testing, it was found that in principle the addition of fiber (palm fiber, plastic, wire) up to 5% of the mixed volume of paving blocks does not give a significant value to the addition of paving block compressive strength. Some of the mixtures tend to decrease the compressive strength compared to the standard compressive strength of the block paving as a comparison. Problems with Column Beam Connections in general, many structural failures are caused by beam-column joints that are caused due to changes in regulations, and there is no planning plan for detailing the number of reinforcement in column beam joints, according to the strength requirements to withstand bending and axial loads. And also because it occurs due to weak ability to withstand shear and low planned ductility. The beam-column joint is an important part of the structure of a multi-storey building.

Ductility according to Paulay & Priestley ductility is divided into:

Transfer Ductility

Displacement ductility is the ratio between the displacement of the maximum structure in the direction of lateal to the displacement of the structure at melting.

$$\boldsymbol{\mu} = \frac{\Delta \boldsymbol{u}}{\Delta \boldsymbol{y}}$$

$\Delta \boldsymbol{u}$ = maximum displacement that occurs

$\Delta \boldsymbol{y}$ = displacement during melting

$\boldsymbol{\mu}$ = Size of structural ductility

The displacement ductility is simply formulated where $\Delta \boldsymbol{u}$ is the total strain due to load and $\Delta \boldsymbol{y}$ is the melting strain. Strain that occurs should not exceed the maximum strain.

Curvature Ductility

Ductility curvature is the ratio between the maximum angle of curvature (angular rotation for unit length) with the angle of melting curvature of a structural element due to bending force. It should be noted that curvature ductility factors Very different from the displacement ductility factor.

At the beginning of producing in a frame, the deformation concentrates on the position of the plastic hinge. Therefore, when the frame is deflected laterally in the range of concrete cracks, ratio φu / φy, in the plastic hinge may be greater than Δu, / Δy ratio.

$$\mu = \frac{\boldsymbol{\varphi u}}{\boldsymbol{\varphi y}} = \frac{\textbf{Curvature Limit}}{\textbf{Curvature when melting}}$$

Rotational Ductility

In the same way, the rotational ductility factor μ is defined as the ratio θu and θy, where θu and θy are rotations at the end of the concrete crack range and at the first yield point of reinforcing steel. So, we have

$$\mu = \frac{\theta u}{\theta y}$$

Strain Ductility, με

Strain ductility can be formulated as follows :

$$\mu_{\varepsilon} = \frac{\varepsilon_u}{\varepsilon_y}$$

with με is strain ductily , με is the maximum strain, and με is the starain at melting. According to SNI - 1726 - 2002, ductility is divided into 2 categories, namely full and partial ductile. Full ductility is a level of ductality of the building structure, where the structure is capable of experiencing post- elastic deviation when it reaches the conditions at the greatest collapse threshold, namely by achieving a ductility factor value of 5.3. Whereas the partial ductile is the entire ductality level of the building structure with a ductal factor value between a full elastic building structure of 1.0 and for a fully ductile building structure of 5.3. [4]

2.METODOLOGY

Time and location of research

This research was conducted in September 2017 until May 2018. The research was conducted at the Earthquake Engineering and Structural Laboratory, Civil Engineering Department, Faculty of Engineering, Hasanuddin University, Gowa.

Research Tools

For testing carried out in the Structure and Materials Laboratory of the Faculty of Engineering, University of Hasanuddin with testing equipment is Strong wall with Cyclic Load Actuator capacity of 1500 KN

The strain gauge will be installed in several locations to measure strain during testing. For strain gauges installed on longitudinal, transversal and diagonal reinforcement. [5]

3.RESULT AND DISCUSSION

A. Testing of Concrete Press Strength

Compressive strength testing refers to SNI 1974-2011 (Compressive strength test method of concrete with cylindrical test object). Compressive strength testing using cylindrical concrete samples of 3 samples (CB-1 and CBF-1) was carried out at 28 days. The results of testing the compressive strength of concrete can be seen in the following table.

						(MPa)		
1	3.57	78.54	2275.28	201.19	25.62			
2	3.57	78.54	2270.19	198.90	25.32	25.36	0.24	25.04
3	3.59	78.54	2282.92	197.44	25.14			
1	3.65	78.54	2322.39	266.01	33.87			
2	3.61	78.54	2299.47	271.25	34.54	33.87	0.67	32.98
3	3.60	78.54	2294.38	260.80	33.21			

From table 1 the results of testing on CB-1 concrete variations above, it can be seen that from the planned 25 MPa concrete quality plan it meets the planned concrete quality with a value of 25.04 MPa from the tests that have been carried out.

Whereas in CBF-1 concrete in table 4.1 above shows the value of the concrete compressive strength that has been tested is

32.98 MPa. From these results it can be seen that the compressive strength of CBF-1 concrete has increased strength by 24.19% with a difference of 8.87 MPa from the concrete quality of the plan. The increase of CBF-1 concrete strength is influenced by the fiber added to the concrete and the bonding capacity between the concrete and bendrat wire. From the above analysis we can see that the addition of fiber to concrete shows an increase in the concrete compressive strength of this matter influenced by fibers added to the concrete and the bonding capacity between concrete and bendrat wire.

B. Testing of Concrete Splice Strength

Testing of Concrete Tensile Strength was carried out in the Laboratory Structure and Material of the Civil Engineering Department of the Faculty of Engineering, Hasanuddin University. The results of testing the strength of Concrete Splits can be seen in table 2.

Tabel 2 Testing of Concrete Splice Strength

Variasi Beton	No	D (mm)	l (mm)	ρ (kn)	f_t (MPa)	Kuat tarik belah (MPa) eksperimental	teoritis	(%)
Normal	1	100	200	106.40	3.39	3.28	3.53	7.08
	2	100	200	96.28	3.06			
	3	100	200	106.15	3.38			
Normal+ Serat 48 mm	1	100	200	127.74	4.07	4.04	4.07	0.73
	2	100	200	125.73	4.00			
	3	100	200	127.26	4.05			

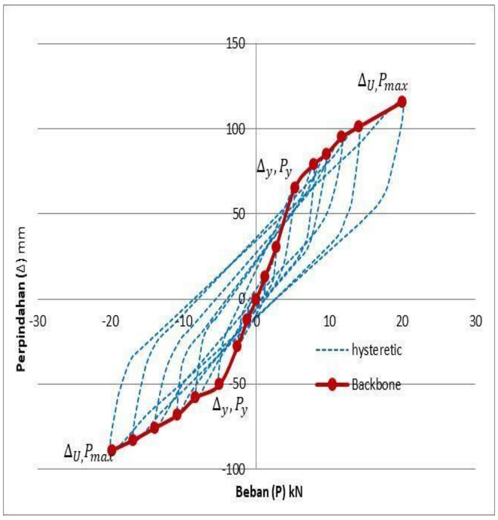
C. Testing of Reinforcement Tensile Strength

This test includes testing the strength of steel reinforcement carried out on all types of reinforcement used, namely D16, Ø8, and Ø10. The results of examination of tensile strength of steel reinforcement can be seen in Table 3.

Table 3. Testing of Reinforcement Tensile Strength

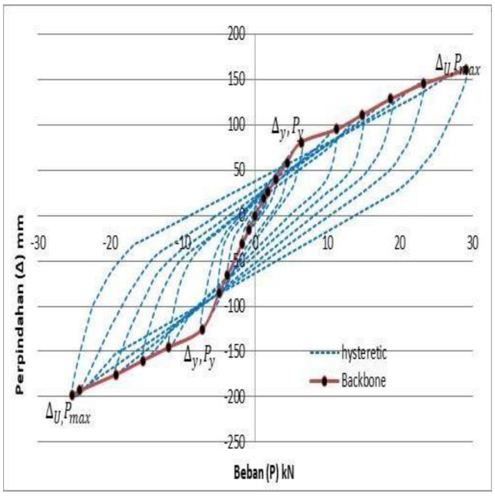
Diameter Besi	As (mm^2)	ρ (kN) P_y(kN)	P_u(kN)	σ (MPa) $σ_y$(MPa)	$σ_u$(MPa)
Ø8	50.24	14.51	16.29	288.81	324.24
Ø8	78.50	22.51	29.04	286.75	369.94
D10	78.50	35.02	48.52	446.11	618.09
D13	132.665	60.83	82.53	458.82	622.09

D. *Relationship between Load and Displacement*



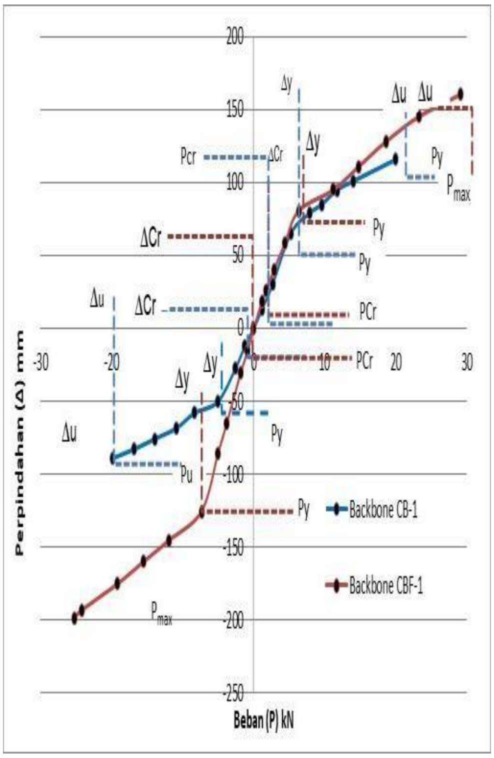
Picture 1 Backbone Curve and Hysteretic CB-1 Test Object Model

The graph above shows that initial cracks occurred at -1.97 mm and 2.18 mm with loads of -12.45 kN and 12,255 kN, yielding occurred at the displacements of - 5.46 mm and 5.25 mm with loads of -26.34 kN and 30,405 kN, and maximum stresses occurred in displacement -19.82 mm and 18.95 mm with loads of -102,915 kN and 131.73 kN



Picture 2 Backbone Curve and Hysteretic Test Object Model CBF-1

The graph above shows that the initial cracks occurred at the displacement of -3.32 mm and 1.73 mm with loads of -28,455 kN and 12,885 kN, yielding occurred in the displacement of -8.84 mm and 7.24 mm with loads of -59,475 kN and 37.77 kN and the maximum stress occurred in displacement -25.54 mm and 29.12 mm with loads of - 208,185 kN and 176.55 kN.



Picture 3 Backbone Curve and Hysteretic Test Object Model Uji CB-1 dan CBF-1

Based on the backbone curve above we can see clear differences between CB-1 and CBF-1 specimens. From these results it can be seen that the displacement of CBF-1 at the time of pull has increased by 27.34% with a difference of 5.42 mm from CB-1 and when press displacement CBF-1 has increased by 53.66% with a difference of 10.17 mm from CB-1. CBF-1 load at the time of pull increased by 102.28% with a difference of 105.27 kN from CB-1 and when pressuring the load CBF-1 increased by 34.02% with a difference of 44.82 kN from CB-1.

Incorrect structure behavior that is important and needs to be reviewed is the ductility value of the structure. Ductality values are calculated to determine the ability of the structure to deform when melting occurs. Based on the maximum displacement and displacement values at the time of melting the coupling beam connection ductality value is obtained as shown in table 4.

Tabel 4 ductility value of coupling beam connection

TYPE		CB1	CBF1
Pcr (kN)	+	1.18 kN	1.19kN
	-	1.27 kN	0.85 kN
Py (kN)	+	65.405 kN	80.77 kN
	-	50.34 kN	125.475 kN
Pmax (kN)	+	115.73 kN	160.55 kN
	-	88.915 kN	198.185 kN
Δcr (mm)	+	13.255 mm	18.63 mm
	-	12.45 mm	15.29mm
Δy (mm)	+	5.25 mm	6.34 mm
	-	5.06 mm	7.34 mm
Δu (mm)	+	19.95 mm	29.12 mm
	-	19.82 mm	25.24 mm
μ	+	3.8	4.59
	-	3.92	3.43
μ rata-rata		3.86	4.01
Keterangan		Daktail parsial	Daktail Parsial

Based on the results of the calculation of the ductility value of the review on the beam shows that the average ductility value. For each specimen is at a partial ductile level according to SNI - 1726 - 2002 that is with a value of μ between 1.5 to 5. This shows that each specimen is in a ductile condition. This indicates that the test object those who do not have the fiber are in ductile conditions whereas the test material which has the fiber is also in ductile conditions.

From table 4 it can be seen that the highest ductality value at the normal connection is 3.62, then the lowest in precast connections that have fiber with a 40 cm notch joint length which is 3.44 and the ductility value for precast joints (CBF1) with a 30 cm notch connection length of 3, 61. This shows that the connection of the precast column beam that is fiber-optic is not better than the normal connection.

Column Beam Connection Conditions

Observation of cracks is carried out on

the test object at the time of maximum loading. Observation of crack patterns is only on one side assuming that the crack pattern that occurs is the same on each side.

It was observed that the cracks during the loading of the Normal coupling beam (BN), coupling beam fiber connection (CBF1) with a length of connection 40 experienced flexural failure. This can be seen from the pattern of cracks that occur in the two specimens is the flexible crack pattern [7]

4.CONCLUSIONS

Based on the results of the calculation of the normal ductility coupling beam connection value and fiber coupling beam connection, it can be concluded that:

1.Data analysis and discussion of fibrous coupling beams have greater ductility than without fiber. Structural performance for normal coupling beam connections and coupling beam joints that have fiber and length is 115 cm so that the beam height is calculated based on length and length ratio to 40 cm height at a partial ductile level.

2.Ductility of test specimens resulting from laboratory testing for CB I and CBF I. Review ductility values on the beam indicate that the value of ductality is flat the average for each specimen is at a partial ductile level according to SNI - 1726 - 2002 with μ values between 1.5 to 5. This shows that each specimen is in a ductile condition where the specimen does not have the fiber experiencing ductile conditions even the opposite test specimen that has these fibers is also in ductile conditions. But the difference between the two different ductile level specimens that increase in precision occurs in the coupling beam which has fiber. The more doses of fiber, the smaller the ductile level, the difference in difference reaches 0.15 MPa between normal concrete and normal concrete + fiber. Based on the results of the experiments conducted, for consideration, some suggestions were proposed as follows:

1.Use of SNI 2847-2013 as a tool for the need to control and supervise test equipment so that during the research there is no damage to equipment that can be detrimental in terms of cost or time

2.It is better to conduct a work plan in conducting research to facilitate the work process.

3.The need for a review of the tools to be used, especially in the hydraulic jack or loading tool, is sufficient loading needed until the test ends.

4.The need for accuracy when carrying out the manufacture of test objects so that the targeted quality can be achieved and not too far from the initial design

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