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Comparison of the Flexural Strength of Reinforced Concrete Beam Using Cold Form Steel Profile as Reinforcement in Osing House

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Abstract— *The use of Beam for the osing traditional house structure is rarely used as a horizontal structural element at the bottom, while this structural element is very important when an earthquake occurs. With the innovation of cold form steel with Double Channel Back to Back arrangement with stifner it can replace the Beam solution which the majority uses reinforced concrete. In this study, C75 cold form steel canal reinforcement will be used as reinforcement for concrete beam structures or for Beams. The aim of this study was to analyze the differences in the flexural strength of concrete beams using C75 cold form steel reinforcement and concrete beams using steel reinforcement. This research was carried out through several stages, namely: procurement of materials and equipment, inspection of materials and equipment, concrete mix planning, concrete manufacture, concrete curing, concrete testing and analysis of research results. The results of this study normal beams have an average flexural strength of 13.45 MPa and beams using cold form steel reinforcement of 14.10 MPa. Meanwhile, the average maximum load of normal beams is 69.67 kN while beams using cold form steel average 70.50 kN. So that with the results that have been obtained, cold form steel canal C75 with the arrangement of Double Channel Back to Back with stifner can be used as an alternative to steel reinforcement, especially on beams with dimensions of 10 x15 cm.*

Keywords— *Reinforced Concrete, Flexible Strong, Light Steel Profile.*

I. INTRODUCTION

Cold form steel (CFS) has become increasingly popular in the last decade [1-7]. The application of CFS to flexural structural elements has been developed by professionals in the construction industry [4]. In the CFS construction industry, this has more economic value in terms of budget plans. Given this, the development of this CFS research has a major contribution, namely developing efficient building structural elements that can be used in the construction of medium or small sized buildings, so that they can be used in traditional houses, one of which is the Osing traditional house. In addition, this research also helps expand the CFS industry, which in turn will lead to a green building and environmentally friendly industry. CFS research on bending elements (beams) states that the use of two or more profiles on a beam increases the ratio of strength to weight [7]. And when two stiffeners are provided in the body, it averages about 40% increase in axial capacity. So with the innovation of cold form steel with Double Channel Back to Back arrangement with stifner it can replace beam solutions which the majority use steel reinforced concrete. In this study, C75 cold form steel canal reinforcement will be used as reinforcement for reinforced concrete beam structures.

II. METHOD

The research method provides an overview of the research design which includes, among other things: the procedures and steps that must be taken, the time of the research, the source of the data, and by what steps the data were obtained and then processed and analyzed. The following can be seen in Figure 1 related to the research flowchart

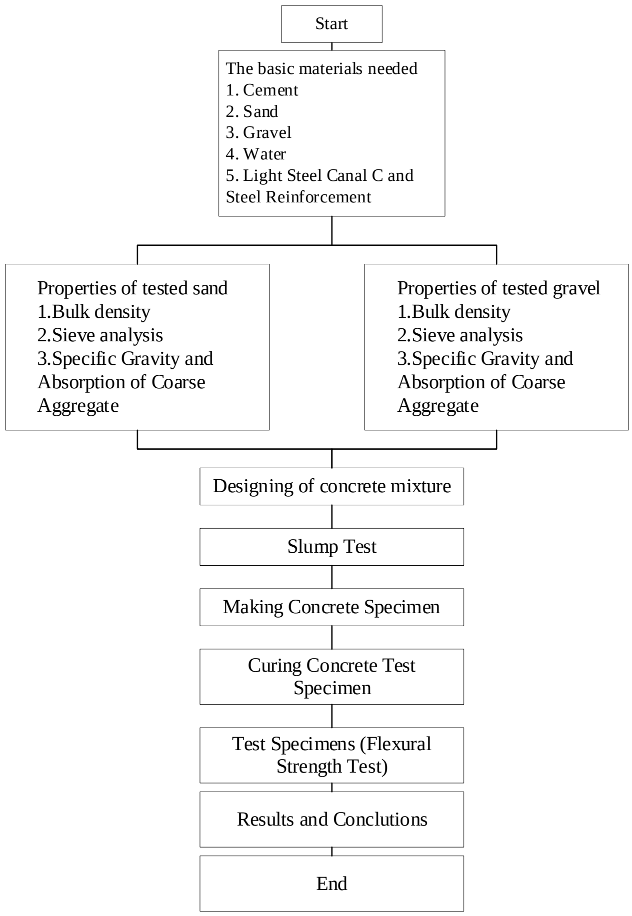

Figure 1. Research flowchart

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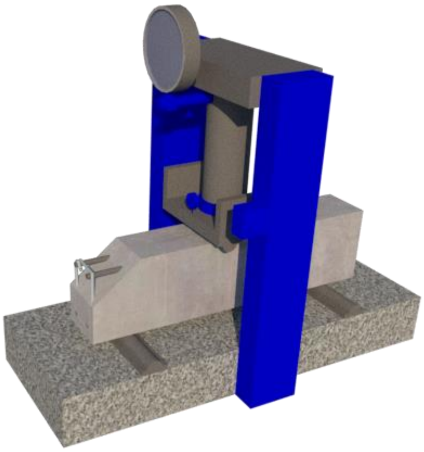

Figure 2. Beam Flexure Test method.

III. RESULTS AND DISCUSSION

Design of Cold form steel Beams and Normal Beams

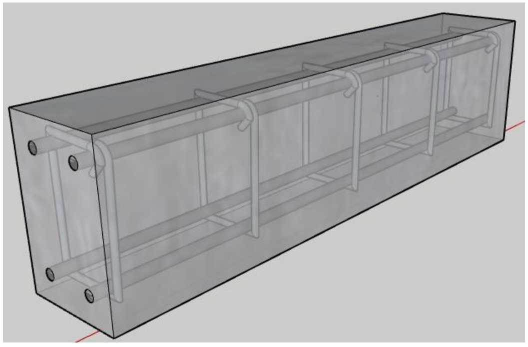

Figure 3. Normal Beam with Main Reinforcement 4Ø12 and Stirrup Ø6-150

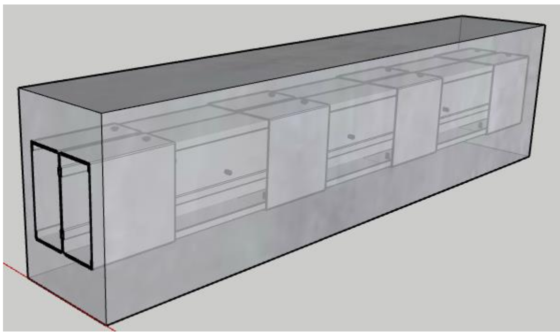

Figure 4. C75 Double Channel Back to Back Cold form steel Beam with stifner

Steel Tensile Strength Test and Concrete Strength Test

Testing the compressive strength of concrete and tensile strength of reinforcing steel using a UTM (Universal Testing Machine) machine. The average compressive strength of concrete cylinders at the age of 28 days is 21.1 MPa. While the results of the tensile strength test of reinforcing steel with a diameter of 10 mm have an average value of yield stress (fy) of 496.67 MPa, and a diameter of 6 mm has an average value of 547.48 MPa. The results can be seen in the table below.

TABLE 1. Steel Tensile Strength Test Table

No	*Test Object Code*	*Area*	*Tensile Force*		*Tensile Strength*		*Elongation*	*Tensile Ratio*
			Yield	*Ultimate*	*Yield*	*Ultimate*		
		mm2	*kN*	*kN*	*MPa*	*MPa*	*%*	
1	P6	29,22	15,79	21,38	540,30	731,57	28,64	1,35
	P6	29,22	15,50	20,78	530,37	711,04	26,03	1,34
	P6	29,22	16,71	21,91	571,78	749,71	29,39	1,31
2	P10	73,90	34,74	49,26	470,11	666,59	27,03	1,42
	P10	73,90	37,57	53,03	508,40	717,61	28,24	1,41
	P10	73,90	37,80	52,10	511,52	705,02	27,38	1,38
3	C1	10,50	8,67	12,64	825,71	1203,81	1,66	1,46
	C2	10,50	9,53	11,67	907,62	1111,43	1,31	1,22
	C3	10,50	7,00	10,55	666,67	1004,76	1,98	1,51

TABLE 2. Concrete Compressive Strength Test Table

No	*Create date*	*Test date*	*Age*	*Weight*	*Dimension*		*Area*	*Compression Force*	*Compressive Strength (fc')*	*Average Compressive Strength (fc')*
					L	*D*				
			(days)	*(kg)*	*(mm)*	*(mm)*	*mm^2*	*(KN)*	*(N/mm^2)*	*(N/mm^2)*
1	29/10/2022	26/11/2022	28	11,8100	300	150	17663	360,000	20,4	21,1
2	30/10/2022	27/11/2022	28	11,6900	300	150	17663	349,140	19,8	
3	31/10/2022	28/11/2022	28	11,6100	300	150	17663	409,761	23,2	

Deflection Load Comparison

The experimental results show that the first normal beam load occurs at an average load of 30 kN with a deflection of 12.2 mm and an average maximum load increases of 69.7 kN with a decrease in deflection of 40.5mm. While the first crack load of the beam with cold form steel occurs at an average load of 30 kN with a deflection that occurs 23.6 mm with an average maximum load of 75.5 kN with a decrease in deflection to 70.9mm

TABLE 3. The results of the beam bending test with reinforcing iron

Specimen		BN1	Specimen		BN2	Specimen	BN3
Weight		21,9 kg	Weight		21,5	Weight	21,3
No	Load (kN)	δ (mm)	No	Load (kN)	δ (mm)	Load (kN)	δ (mm)
1	0	0	1	0	0	0	0
2	10	49	2	10	73	10	119
3	20	82	3	20	114	20	164
4	30	122	4	30	162	30	205
5	40	171	5	40	205	40	241
6	50	216	6	50	249	50	277
7	60	263	7	60	350	60	322
8	70	364	8	70	450	69	401
9	52	428	9	49	494	54	430

Normal beam tests have an average flexural strength of 13.45 MPa with a maximum load of 69.67 kN and cold form steel beams have an average flexural strength of 14.10 MPa with a maximum load of 75.50 kN. As for the crack patterns due to bending loads, the average experienced flexural cracks for

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normal beams and shear and spalling cracks for CFS beams with stifner.

TABLE 4. The results of the bending test of the beam with cold form steel

Specimen		BC1	Specimen		BC2	Specimen	BC3
Weight		21,0	Weight		21,4	Weight	20,5
No	Load (kN)	δ (mm)	No	Load (kN)	δ (mm)	Load (kN)	δ (mm)
	0	0		0	0	0	0
1	10	65	1	10	7,5	10	102
2	20	117	2	20	18	20	174
3	30	154	3	30	32,3	30	233
4	40	192	4	40	39,4	40	286
5	50	232	5	50	47	50	349
6	60	280	6	60	56,3	60	477
7	70	379	7	70	60,9	70	710
8	76,5	576	8	80	79,5	55	756
9	63,5	690	9	56	89,8		

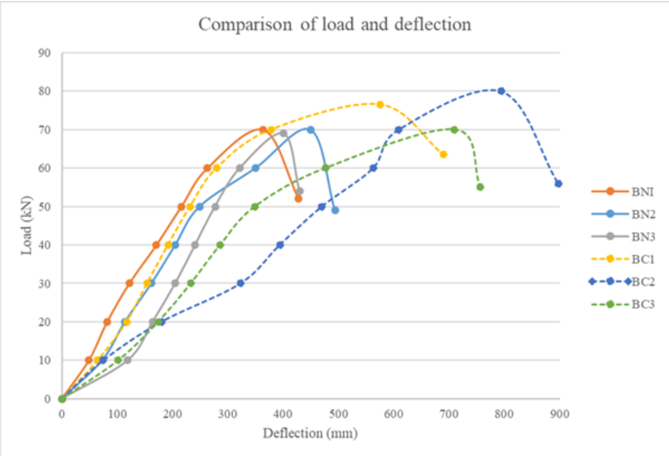
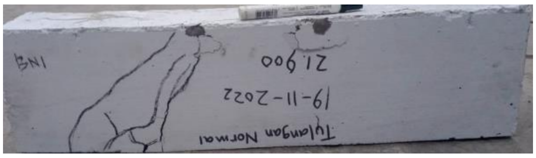


Figure 4. Load and deflection comparison graph

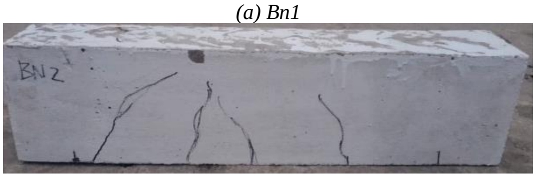
TABLE 5. Beam Flexure Test Table

No of Sample	**BN1**	**BN2**	**BN3**	**BC1**	**BC2**	**BC3**
Curing Ages (Hari)	28	28	28	28	28	28
Width, b (cm)	10	10	11	10	10	10
Height, h (cm)	15	15	15	15	15	15
Length, L (cm)	60	60	60	60	60	60
Weight (kg)	22	22	22	22	22	22
Volume (cm3)	9360	9000	9630	9000	9000	9000
Density (kg/m3)	2	2	2	2	2	2
Max. Load (N)	70000	70000	69000	76500	80000	55000
Length Span (mm)	450	450	450	450	450	450
Fracture	1	1	1	1	1	1
Cross-sectional Width = b (mm)	104	100	107	100	100	100
High Latitude = h (mm)	150	150	150	150	150	150
The average span length between the fracture section and the closest external support beam = a (cm)	-	-	-	-	-	-
Flexural strength test = σ1(Mpa)	**13,46**	**14,00**	**12,90**	**15,30**	**16,00**	**11,00**
Average flexural strength (Mpa)		**13,45**			**14,10**	

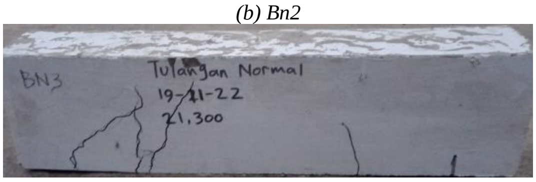
Normal beams have an average flexural crack at the beginning, then a shear crack that forms diagonally to the load bearing. Then the beams using cold form steel average shear cracks and spalling in several beams. This is due to one of the reasons that the bond on cold form steel is less than optimal. For a picture of the crack pattern of the test object, it can be seen in the image below.



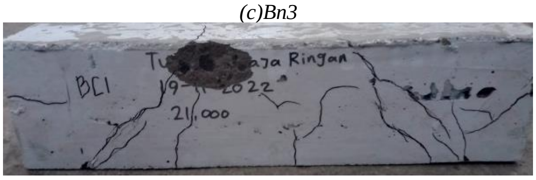
(a) Bn1



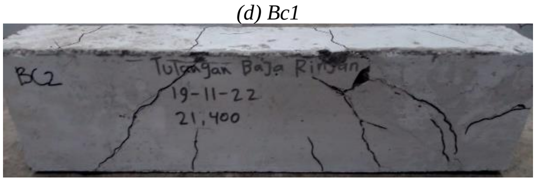
(b) Bn2



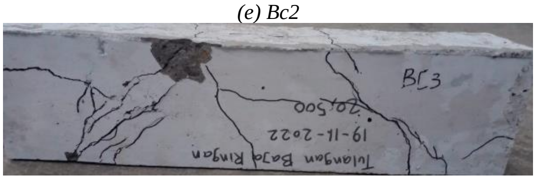
(c)Bn3



(d) Bc1



(e) Bc2



(f) Bc3

Figure 5. Crack Pattern of Test Beams

IV. OTHER RECOMMENDATIONS

It is necessary to develop the use of light steel in other structures in the traditional Osing house and to develop research on Osing houses using cold form steel materials that are environmentally friendly and earthquake resistant.

V. CONCLUSION

The results of this study normal beams have an average flexural strength of 13.45 MPa and beams using cold form steel reinforcement of 14.10 MPa. Meanwhile, the average maximum load of normal beams is 69.67 kN while beams using cold form steel average 70.50 kN. The crack pattern of these beams for normal beams averaged shear flexural cracks, while for CFS beams experienced shear cracks which were characterized by a crack motion that was directed diagonally towards the load bearing.

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