Analysis of Precast Hybrid Concrete Beam with Lightweight Concrete at Tension Maximum

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Abstract: For several cases of delivery of beam is location for install such as location for manoeuvre. Another case is available of material for mixing concrete as fine aggregate and coarse aggregate. For that cases research about segmental girder was needed and was done with lightweight concrete as material for reduce weight of its beam and called precast hybrid concrete beam. Question of this research is how about strength of flexural hybrid beam if any load were applied and how about deflection occur. Aim of this research was investigated of strength of flexural hybrid beam and deflection occur if compared with conventional beam. This research consist of two types of precast beam that was hybrid beam (BU227 and BU 228) and conventional beam (BU226). Result of precast hybrid concrete beam BU227 and BU228 and conventional beam BU226 were strength of flexural beam at ultimate and deflection of beam at ultimate. For strength of flexural conventional beam BU 226 at ultimate was achieved 10,48 T at deflection 29,6 mm. For strength of flexural precast beam BU 227 at ultimate was achieved 10,15 T at deflection 23,43 mm and for strength of flexural precast beam BU 228 at ultimate was achieved 10,33 T at deflection 27,19 mm. Average compressive strength of lightweight concrete was achieved 49,58 kg/cm2.Conclusion of this research is both of precast hybrid beam are having good performance and can be applied at location with difficult to manouevre and difficult for availability of materials for mixing concrete.

1 INTRODUCTION

This research was investigated of strength of flexural and deflection of precast hybrid concrete beam. Precast hybrid concrete beam was explained about using of diversification two materials as normal concrete and lightweight concrete.

The benefit of using precast hybrid concrete beam is more effective for construction than conventional beam (cast in site) and minimize cost of construction. Research of strength of flexural and deflection between diversification of two materials was investigated, Apparao and Bing Li (2009), Sebastián et al. (2013), Baharudin et al. (2006), Sneed et al. (2016), Farnoud et al. (2017),explained of influence of roughness at surface of floor concrete will be connected with topping system using steel fiber reinforce concrete (SFRC). Question of this research is how about strength of flexural hybrid beam if any load were applicated and how about deflection occur. Aim of this research was investigated of strength of flexural hybrid beam and deflection occur if compared with conventional beam

1.1 Lightweight Concrete

Refer to SNI 03-3449-2002,lightweight concrete structure have fine aggregate or mixing fine aggregate and coarse aggregate and determine of density not more than 1850 kg/m3 (Royce et al, 2015).

This research was used mixing only fine aggregate, cement with water and additive foam agent (ADT) and additive foam concrete (ADT).

1.2 Shear Horizontal

Code of ACI 318-2011 at chapter 17.5 and SNI 03-2847-2013 was explained for shear horizontal Vnh have to meet a demand:

$$Vu \leq \phi\ Vnh \quad (1)$$

$$\phi\ Vnh\ 1 = \phi.\ 80.Bv.d \quad (2)$$

$$\rho v = Av / Bv.S$$

$$\phi\ Vnh\ 2 = \phi\ (\ 260 + 0{,}6.\rho v.\ fy\ )\ \lambda..Bv.d \quad (3)$$

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ϕ Vnh 3 = ϕ.500.Bv.d (4)
ϕ.80.Bv.d < Vu < ϕ. 500.Bv.d < ϕ (260 + 0,6.ρv. fy) λ.Bv.d (5)
Av min = 0,75.(fc')^0,5 .Bw.S / fyt (6)
λ = 1 for normal condrete and 0.75 for *ligthweigth concrete*

2 RESEARCH METHOD

Testing elements were used location at Bina Teknik Permukiman dan Perumahan Direktorat Jenderal Cipta Karya Kementerian PUPR Jl. Panyaungan, Cileunyi Wetan Kab. Bandung. This research have 2 samples precast hybrid concrete beam and 1 sample precast conventional beam. All of samples would be tested flexural tensile strength dan 5 samples for tested tensile strength reinforced bars. Reinforced bars used D12,59 mm. **Figure 1a and 1b** was showing prototype element precast hybrid concrete beam and conventional beam.. **Figure 2** was showing element precast hybrid beam BU227 will be tested and **Figure 3** was showing element precast hybrid beam BU228 will be tested also **figure 4** was showing element conventional beam BU226 will be tested.

Figure 5 was showing element precast hybrid beam BU227 has tested and **Figure 6** was showing element precast hybrid beam BU228 has tested also **figure 7** was showing element conventional beam BU226 has tested. For method of loading test, can refer to figure 2,figure 3 and figure 4.

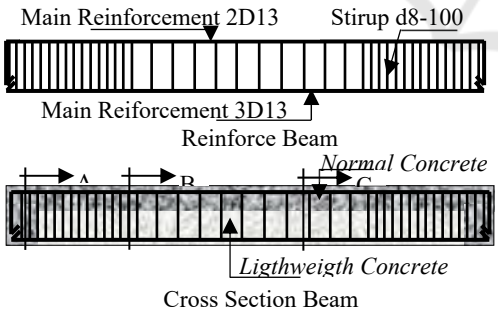

Figure 1a: Prototype element precast hybrid concrete beam and conventional beam

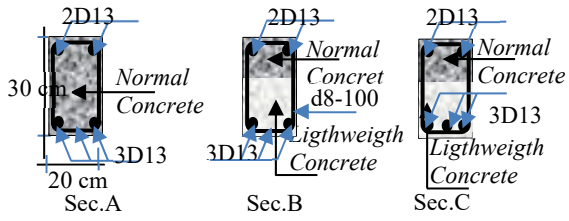

Figure 1b: Cross Section beam

Figure 2: Element precast hybrid beam BU227

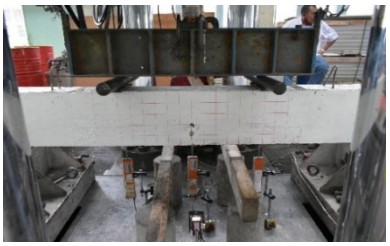

Figure 3: Element precast hybrid beam BU228

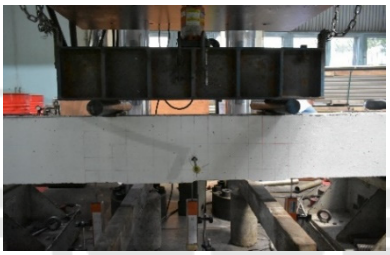

Figure 4: Element precast conv. beam BU226

Figure 5: Element precast hybrid beam BU227 has tested

Figure 6: Element precast hybrid beam BU228 has tested

Figure 7: Element precast hybrid beam BU226 has tested

3 RESULT AND DISCUSSION

Research of precast hybrid concrete beam for all specimen indicate that precast hybrid concrete beam was capable for resistance under loading same as with precast conventional beam, accordingly all specimen indicate of strength of flexural and deflection was not different respectively and will be explained at below. For pattern of crack, all of specimens have pattern of crack were same crack due of moment, indicate that all specimen have same behavior. Average compression strength of lightweight concrete was 49,58 kg/cm2 and average density is 1842 kg/m3.

For strength of flexural conventional of beam BU 226 at ultimate was achieved 10,48 T at deflection 29,6 mm. For strength of flexural precast beam BU 227 at ultimate was achieved 10,15 T at deflection 23,43 mm and for strength of flexural precast beam BU 228 at ultimate was achieved 10,33 T at deflection 27,19 mm. **Table 1** showing result of loading test and deflection also **figure 8** showing chart of loading versus average of deflection.

Table 1: Result of Flexural Test

No	Element	Range Load	Range Defl.
		T	mm
1	BU 226 Conventional	0,00 - 1,02 1,18 - 2,00	0,00 - 0,85 0,90 - 1,53
		2,12 - 2,95 3,10 - 4,02 4,15 - 4,98 5,11 - 5,95 6,10 - 7,08 7,20 - 8,01 8,15 - 9,00 9,08 - 10,48	1,60 - 2,13 2,24 -2,86 2,91 - 3,49 3,53 - 4,18 4,25 - 5,11 5,19 - 5,79 5,84 - 6,58 6,65 - 29,6
2	BU 227 Precast 1	0,00 - 1,08 1,22 - 2,08 2,18 - 3,05 3,17 - 4,02 4,12 - 5,05 5,16 - 5,91 6,15 - 6,98	0,00 - 1,45 1,50 - 2,19 2,28 - 2,90 3,05 - 3,90 3,98 - 4,71 4,78 - 5,33 5,66 - 6,39
		7,11 - 8,05 8,16 - 9,00 9,01 - 10,15	6,46 - 7,19 7,44 - 10,34 10,44 - 23,43
2	BU 228 Precast 2	0,00 - 0,98 1,10 - 1,98 2,18 - 2,78 3,12 - 3,95 4,15 - 4,96 5,18 - 6,00 6,26 - 7,00 7,18 - 8,03 8,15 - 9,00 9,03 - 10,33	0,00 - 0,67 0,71 - 1,20 1,53- 1,88 2,13 - 2,73 2,86 - 3,43 3,68 - 4,22 4,53 - 5,11 5,17 - 5,96 5,99 - 10,51 10,62 - 27,19

Table 1 explain result of loading test specimen BU226,BU227 and BU228. It is clear that result all of specimen indicate have same performance. Diversification strength of flexural among BU226 and BU227 was not far only 3,15% and Diversification strength of flexural among BU227 and BU228 was not far only 1,74% and diversification of deflection among BU227 and BU228 was 3,66 mm. If average strength of flexural BU227 and BU228 was value 10,48 T that by interpolation has result of deflection 30,32 mm is not far from value deflection 29,60 mm only has diversification 0,72 mm or 2,4%.

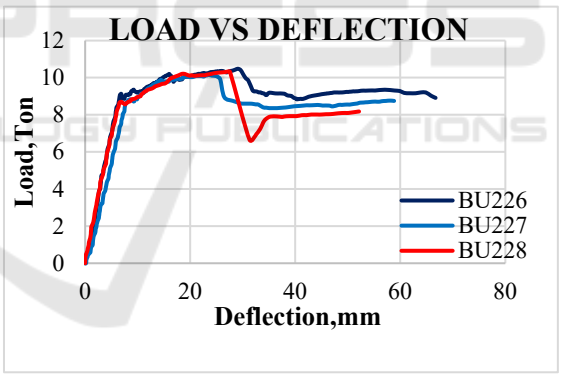

Figure 8: Result of BU226,BU227,BU228

Shear connector for prevent of effect of shear horizontal was not influenced. Result for shear horizontal have been explained that using stirrup diameter d8 was enough to arrest effect of Vu occur at edge of beam.

For pattern of crack all of specimen have same as pattern of crack, crack cause of moment, indicate that all specimen have same behavior. Therefore for precast hybrid concrete beam if using lightweight concrete then have to put normal concrete at right and left of element of hybrid concrete beam.

The benefit of using precast hybrid concrete beam is more effective for construction than conventional

beam (cast in site) and minimize cost of construction, cost of all element will be cheaper and can be applicated at location with difficult to manouevre and difficult for availability of materials for mixing concrete.

4 CONCLUSION

Result of precast hybrid concrete beam BU227 and BU 228 were strength of flexural beam at ultimate and deflection of beam at ultimate. For strength of flexural conventional beam BU 226 at ultimate was value 10,48 T at deflection 29,6 mm. For strength of flexural precast beam BU 227 at ultimate was value 10,15 T at deflection 23,43 mm and for strength of flexural precast beam BU 228 at ultimate was value 10,33 T at deflection 27,19 mm. Diversification strength of flexural among BU226 and BU227 was not far only 3,15% and Diversification strength of flexural among BU227 and BU228 was not far only 1,74% and diversification of deflection among BU227 and BU228 was 3,66 mm. If average strength of flexural BU227 and BU228 was value 10,48 T that by interpolation has result of deflection 30,32 mm is not far from value deflection 29,60 mm only has diversification 0,72 mm or 2,4%. Result all of specimen indicate have sam.e as performance.

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