Precast Concrete on Beam Column Connection Using Coconut Shell By Experimentation

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Abstract- *One of the sustainable alternative aggregates is coconut shell (CS) and coconut shell concrete (CSC) was established a decade ago. CSC precast elements and their behavioral studies are very limited. Joints capacity and behavior are significant in precast concrete elements. Hence, in this study precast column — beam behavior of CSC elements was studied. To start with, to connect the precast elements two different sizes 12 and 16 mm bolt and nuts connection was selected and used. The same sectional details were also used and specimen were produced with conventional concrete (CC) for comparison purpose. Monolithic elements of both CC and CSC were also cast and tested. Failure of both monolithic and precast CSC elements specimen were typical structural failure and are comparable to that of CC, High deflection were observed on CSC element compared to CC. No cracks were formed on precast specimen both in CC and CSC. All elements were able to achieve their full strain capacity. However, there are some deficiency faced in this study like occurrence of slip in precast elements.*

I. INTRODUCTION

A) PRECAST TECHNOLOGY

Construction is the crucial industry for economies as it adds mainly to gross domestic product (GDP) India had only 6.6% GDP in January 2019, According to overall statistical data, construction industry in India redeemed its growth in 2018, aided for encouraging developments in economic, improvement in investor self- reliance and investments in transport infrastructure, energy and other housing projects. The aim of Government's 'Housing for All' is to build 20 million homes for urban poor by 2022. There is a greater demand for residential construction works over the forecast period due to developments in regional economic conditions To achieve this target and to meet the demands, there is an essential for the construction division to expand its efficacy by implementing an innovative technology which includes precast

B) LIGHT WEIGHT CONCRETE (LWC)

Making of concrete in light weight is one of the special concretes called LWC where the density is comparatively less than that of traditional concrete, The LWC has several advantages including reduced self-weight, good insulation and fire resistance [Weigler H (1980)] The weight density of LWC ranges 300 - 1850 kg/m' not more than 2200 kg/m' as given by BS EN 1992-1-1. Even with drastic reduction in density, LWC has sufficient strength and is also economical LWC has better thermal insulation capacity, good fire resistance, superior seismic resistance and better sound absorption than normal weight concrete (NWC), The reduced density leads to reduced foundation load and eventual reduction in total construction cost. Whatever may be the types of concrete, aggregates form the main constituent of concrete and occupy nearly 80% of volume of concrete They hold an influential part in concrete properties Aggregates used in concrete are classified as normal, light and heavy aggregates with respect to the weight depending on the characteristics of the parent material

COCONUT SHELL CONCRETE

Utilization of coconut shell (CS) in the production of LWC is a relatively new field. Research available on LWC with CS has shown it as a novel idea with strength and durability properties within the acceptable standard recommendations. Extensive work has been done in the development of LWC made with CS aggregate by the researchers group Gunasekaran et al (2010, 201 la and 2011b). In the report of their investigation on the normally vibrated coconut shell concrete (CSC), 510 k%m3 cement was used in two different w/c ratios 0.42 and 0.44. Strength of CSC under flexural test was 17 53% and 16.42% of the corresponding strength under compression. Split tensile strengths of CSC were also about 10.11% and 9.17% of the corresponding strength under compression. Modulus of elasticity achieved was 5357 N/mm', which was 1/3 of the control concrete (CC) [Gunasekaran K (2010), Gunasekaran K (2011a), Gunasekaran K (201 I b)]. Further works were also carried out by Gunasekaran et al. to evaluate long term strength and bond characteristics of CSC [Gunasekaran K (2012), Gunasekaran K (2015)]. However the study on precast beam element using

CSC and its behaviour is limited. Therefore, more researches possibilities in precast CSC will lead to new findings. The following study is one such research on precast CSC elements.

OBJECTIVES

With the overall aim to study the behavior of precast beams using CSC, the following objectives were set out in the course of this study:

- To prepare beam-column joints both in monolithic and prefabrication construction of conventional and coconut shell concrete grade M25.
- To adopt two different size of bolt and nut connection between the precast elements.
- To test the specimen for observing the joint behavior and other characteristics

SCOPE OF WORK

In this study, beam-column joints in monolithic and prefabrication elements of conventional and coconut shell concrete will be cast of M25 grade. Two different size of bolt and nut connection will be adopted between the precast elements. The specimen will be tested for their joint behaviour and other structural parameters like strain, deflection behaviour will be studied.

II. REVIEW OF LITERATURE

Qin Gao ct al (2019), studied on “Cyclic loading test for interior precast SRC beam-column joints with and without slab” They reported that for superior execution, joint sections were used in Steel Reinforced Concrete (SRC) in the junction of beam-column Results of this study gave an awareness to engineers in design of precast joints.

Dong Junyan ct a1 (2019), done the work on “Study on connection and properties of green assembled building steel structure” Results of this study showed that the joints are to be properly considered for its better behaviour The welded joint exhibited good welding forming quality and the hardness is high .

Peep Piheloa ct al (2017) studied about “Renovation with Prefabricated Modular Panels”They concluded that the analysis and the design itselfis essential to consider the early state of the building The challenges in this process is very important for the interaction between the design and construction the engineers and designer should include hydrothermal modelling in design practices to promise the safety and sustainability. materials used in this study: Ordinary Portland Cement (OPC), River Sand (RS), CS, crushed stone aggregate (CSA) from granite and water are discussed in this section. At the end of this chapter, flow chart of methodology which covers the entire workflow is presented.

AGGREGATES

For flne aggregate, RS of 2.68 specific gravity and 2.92 fineness modulus was used. The availability of coconut shells in industries is shown in. Coconut shells were collected and they were crushed using the crusher developed and used as coarse aggregates. Crushed and collected CS are shown in Figure 3 3 The Figure 3 4 indicates the crushed size of CS aggregates.

3.1. Collected coconut shell

3.2. **Crushed and collected coconut shell**

3.3 Coconut shell crusher

Literature suggested that use of 12 5 mm compared to 20 mm size of CS because or' its 100% flakiness for any size and hence the size of CS used in this study was 12.5 mm. For the production of conventional concrete (CC) also 12.5 mm sized stone aggregate was used for comparison which had specific gravity 2.69 and fineness modulus 6.85.

III. MIX DESIGN

Table3.1 Mix ratio used

Description	**Conventionalconcrete** (CC)	**Coconut shell concrete**(CSC)
Mix ratio	1:2.22:3.66	I:1.47:0.65
Cement(kg/m2)	320	510
W/C ratio	0.55	0.42

EXPERIMENTAL INVESTIGATION:

Table 3.2 Fresh concrete properties

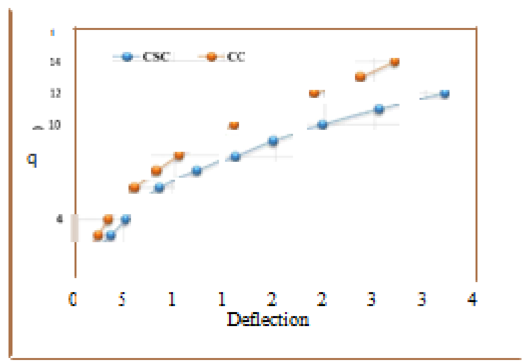
Mix	**Slump**	**Compaction Factor**	**Density (kg/m3)**
CC	8	0.90	2480
CSC	10	0.92	2025

HARDENED CONCRETE PROPERTIES

Table3.4 Hardened concrete properties

Mix	**3days**		**7days**		**28days**	
	Density kg/m3	**Strength N/mm2**	**Density kg/m3**	**Strength N/mm2**	**Density kg/m3**	**Strength N/mm2**
CC	2440	17.95	2445	22.40	2535	30.20
CSC	1965	16.80	1975	19.90	1995	26.80

PREPARATION OF SPECIMEN



Load Vs Deflection (Monolithic)

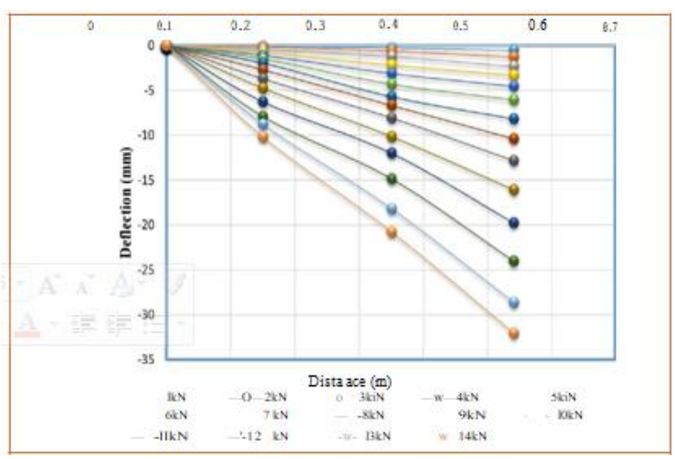


Figure 5.8 Deflection profile of CC monolithic element

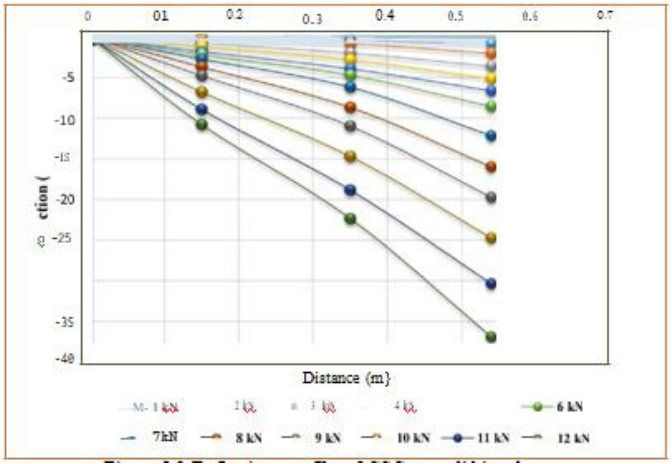


Figure 5.9 Deflection profile of CSC monolithic element

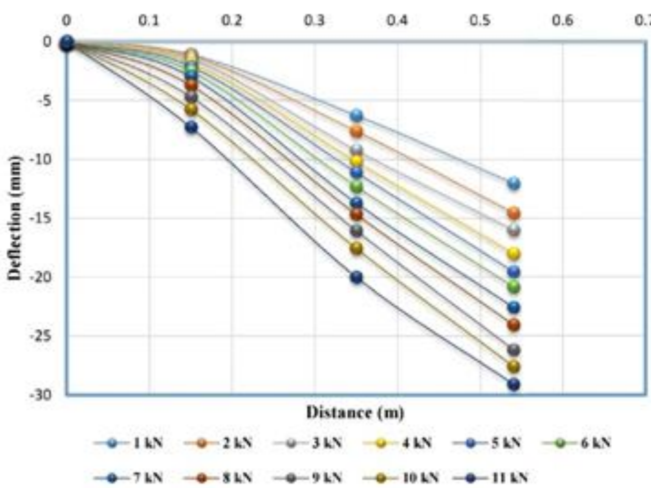


Figure 5.10 Deflection profile of CC 12 mm bolt element

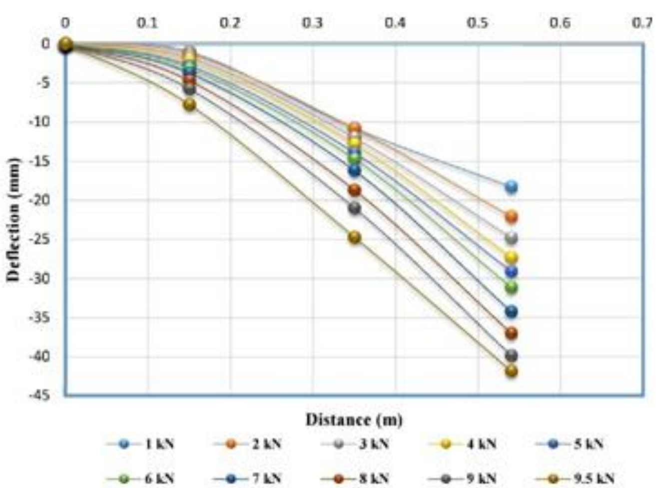


Figure 5.11 Deflection profile of CSC 12 mm bolt element

CRACK PATTERN

Cracks formation and their propagations were measured and marked since beginning to end of the test on all specimen. First crack was occurred in place of column-beam junction in case of both in CC and CSC monolithic element.

Uplift and crushing of CSC specimen

STRAINS

For every load increment concrete and steel strains were measured. Strain distributions for concrete and steel for both CC and CSC beams of monolithic, provided with 12 mm size bolts and 16 mm size bolts.

Steel tension strain at ultimate load		Steel tension strain at service load		Surface concrete strain at ultimate load		Surface concrete strain at service load	
CC	CSC	CC	CSC	CC	CSC	CC	CSC
Monolithic elements							
3442	2897	1634	1376	1556	2485	526	1190
Precast elements provided witb 12 mm size bolt							
1529	1459	41	817	616	1329	270	506
Precast elements provided witb 16 mm size bolt							
2045	1889	1354	1258	1616	1678	712	1096

fable **5.8 Strain** gauge values for CC **and** CSC precast specimen (12 mm bolts

Load (kN)	CC — Precast (12 mm bolt)		CSC — Precast (12 mm bolt)	
	Tension Strain (X 10‘‘)	Compression Strain (X 10 ‘)	Tension Strain (X 10‘ ‘)	Compression Strain (X 10‘ ‘)
0	0	0	0	0
1	0	0	0	0
2	191	27	206	71
3	359	33	377	91
4	577	54	591	129
5	672	130	736	322
6	718	181	817	506
7	841	270	949	720
8	944	351	1118	881
9	1209	389	1365	1032
9.5		-	1459	1329
10	1394	510		
11	1529	616		

Table 5.9 Strain gauge values for CC and CSC precast specimen (16 mm bolts

Load (kN)	CC — Precast (16 mm bolt)		CSC — Precast (16 mm bolt)	
	Tension Strain (X 10‘‘)	Compression **Strain** (X 10’‘)	Tension **Strain** (X 10 6)	Compression Strain (X 10 6)
0	0	0	0	0
1	0	0	0	0
2	144	21	158	55
3	274	26	289	71
4	448	44	456	99
5	554	102	545	254
6	589	152	687	384
7	667	209	779	556
8	864	274	985	674
9	999	317	1134	779
10	1087	394	1202	946
11	1178	489	1258	1096
12	1258	601	1354	1199
13	1354	712	1442	1287
14	1452	804	1552	1345
15	1587	908	1647	1456
16	1689	1002	1787	1544
17	1745	1125	1889	1678
18	1845	1241		
19	1987	1487		
20	2045	1616		

IV. CONCLUSIONS

Typical structural behavior like CC was observed in both monolithic and precast elements produced using CSC. The following are the conclusions made from the study:

- No cracking was occurred on precast elements even at the ultimate stage.
- In case of monolithic elements, the capacity ratio of CC and CSC are found to be 1.68 and 1.48, respectively.
- For the sectional details used in this study, 2 numbers of 12 mm bolts provided are not sufficient and 2 numbers of 16 mm bolts are sufficient.
- The deflection of CSC element was comparatively high compared to CC element due to the porous nature, less stiffness and low density of CS
- In all the monolithic elements, the cracks were occurred in the maximum flexural zone (i.e) well before half the span of the beam which shows that the behavior of CSC is similar to that of CC element.
- No cracks were formed on precast specimen both in CC and CSC for the type of connections used in this study and hence more attention to be given in future to avoid the slip happened between the bolts and the elements.
- CSC elements used in this study were able to achieve its full strain capacity. Over all, column — beam joint behavior of CSC monolithic and precast specimen behavior are comparable to that of CC.

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