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Study on Behaviour of Bamboo as Reinforcement with Coconut Shell as Aggregate Concrete in Compression Member with Different Lengths

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ABSTRACT
The use of waste materials is one of the options for sustainable construction. Crushed stone is usually used as coarse aggregate in concrete, which is generally a non-renewable natural resource. Steel, which is used for reinforcement in construction industry requires lot of energy for its production and its use has been widely increased which keeps India in fourth position in steel production. In this project the coconut shell waste is considered as coarse aggregate (after the same has been crushed) for preparing light weight concrete. The natural material like bamboo which is having considerable tensile strength is considered for reinforcement along with coconut shell concrete. Since the bamboo may absorb moisture from the concrete, for that bamboo is treated with water repellent substance like epoxy adhesive is considered. Short columns of various lengths were studied in this work. The columns with replaced coconut shell aggregate with bamboo reinforcement and columns with replaced coarse aggregate with steel reinforcement were compared with the conventional concrete with steel reinforcement specimens. The ultimate load carrying capacity of the columns decreased with the increase in length. The stiffness of the columns also decreased with the replacement of aggregate and reinforcement.

Keywords
Columns; reinforcement; coconut shell; aggregate; treated bamboo.

1. INTRODUCTION
Concrete is the widely used structural material in the world. The demand for concrete has been increased because of the development of infrastructure all over the world. Among all the ingredients of the concrete, aggregates form the major part. Therefore as the demand for concrete has been increasing demand for coarse aggregate also been increasing. This aggregates were generally crushed natural stone which is a non-renewable resource. The challenge is to make the concrete light weight as the density is the major disadvantage in concrete and also the utilization of wastes. This light weight concrete is achieved by decreasing the density which can be done by replacing the natural aggregate with the light weight aggregate. This was generally achieved by replacing the coarse aggregate with light weight aggregate. There were several wastes all around the world which cause pollution. Coconut shell which was considered as the waste can be suitable to replace the natural aggregate. Coconut shell after crushing can be used as a replacement and also proved to be light weight. Coconut shell represents more than 60% of the domestic waste volume. Coconut shell wastes present serious disposal problems for local environment. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes. Thus use of coconut shell aggregates makes the concrete light weight and also eco-friendly.

A lot of research was carried out with the replacement of coconut shell aggregate and was proved to be an appropriate replacement for the coarse aggregate achieving the lesser density thereby attaining light weight concrete.

Steel which is used as reinforcement requires lot of energy for its production. As of today India stands in fourth position in the production of steel. Almost 87millions tons were produced in India. The cost of the steel was also very high and was approximately Rs.40,000 per ton. This makes the concrete non ecofriendly and uneconomical. Thus there is a need for a new material for replacing the reinforcement.

Bamboo is a giant grass which grows very fast and is a widely available, cheap and renewable resource. Bamboo is used as a construction material in both technical and non technical ways from the olden days. Bamboo is widely grown in India and all around the world. Due to the similar characteristics of bamboo with steel in mechanical properties, lot of research was carried out to use bamboo as a structural material. Most of the research shows that the compressive strength of the bamboo is smaller than that of the tensile strength. The treated bamboo shows higher strength than that of the untreated one, this is because of the reason that bamboo absorbs water. Many of the researchers have performed the test on the short columns with different types of reinforcement under axial loading to investigate the strength capacity and ductility. Hence a study was made to know the behaviour of bamboo in columns with different lengths. The bamboos used as reinforcement in this study were treated as the research shows treated bamboo have better performance compared to the untreated bamboo. Research has also proved that the column containing untreated bamboo shown less ductility than that of the bamboos with treated bamboo.

The present study uses coconut shell as coarse aggregate and bamboo as reinforcement to study the columns with different lengths.

2. MATERIALS
OPC of grade 53 was used in this study. Fine aggregate, which was river sand passing through 2.36mm sieve was used. Crushed

Coconut shell passing through 12.5mm was used.
SP-dera type of bamboo was used for this study.

Figure 1: Crushed Coconut shell

Figure 2: Treated Bamboo Specimen

3. METHODOLOGY

Various specimens were cast with three varying lengths i.e., 1m, 1.15m and 1.3m and were given below

1. Columns with conventional coarse aggregate and steel reinforcement.
2. Columns with coconut shell aggregate and steel reinforcement.
3. Columns with coconut shell aggregate and bamboo reinforcement.

4. EXPERIMENTAL WORK

Columns with conventional concrete were cast with mix proportion of cement: sand: coarse aggregate in the ratio of 1:2.22:3.66 with a w/c ratio of 0.55. This was cast with 4 steel bars of diameter 12mm and 8mm diameter stirrups at 100mm spacing.

Columns with coconut shell aggregate were cast with mix proportion of cement: sand: coarse aggregate in the ratio of 1:1.47:0.65 with w/c ratio of 0.42. Coconut shell aggregate was initially soaked in water for 24hrs prior to casting and dried in sunlight.

Bamboo was cut into 4 parts diameter wise and was made to 12mm approximately. An epoxy resin was applied over the bamboo and allowed to dry. The bamboo was tied with binding wire with 1inch thread and made as reinforcement with steel stirrups of 8mm diameter at 100mm spacing.

A clear cover of 25mm was provided. Concrete was placed in to the moulds with reinforcement and well compacted using a needle vibrator.

The specimens were demoulded after 24hrs of casting and cured in water for 28days.

Figure 3: Few Freshly Cast Specimens

Figure 4: Treated bamboo with binding wire

Fig 5: Soaked coconut shell aggregate

5. TEST RESULTS AND DISCUSSIONS

All the specimens were tested after 28 days of curing in a column testing machine of 40T capacity. Two deflectometers were placed on two opposite sides of the specimen to measure the deflections. The columns were loaded axially using a hydraulic jack and with a proving ring setup.

Load deflection curves for different columns were drawn and were shown in the figures 7, 8, 9. The ultimate load carrying capacity of the columns of 1m length with conventional concrete and steel reinforcement was 220kN where as the column with coconut shell aggregate and steel reinforcement was about 190kN and column with coconut shell aggregate and bamboo reinforcement was about 140kN. The ultimate load carrying capacity of columns with 1.15m length with conventional concrete and steel reinforcement was 205kN whereas the column

with coconut shell aggregate and steel reinforcement was about 165kN and column with coconut shell aggregate and bamboo reinforcement was about 140kN. The ultimate load carrying capacity of columns with 1.30m length with conventional concrete and steel reinforcement was 200kN whereas the column with coconut shell aggregate and steel reinforcement was about 155kN and column with coconut shell aggregate and bamboo reinforcement was about 135kN. The variation of ultimate load carrying capacities of different lengths of columns was shown in figure 10.

Figure 6: Test setup

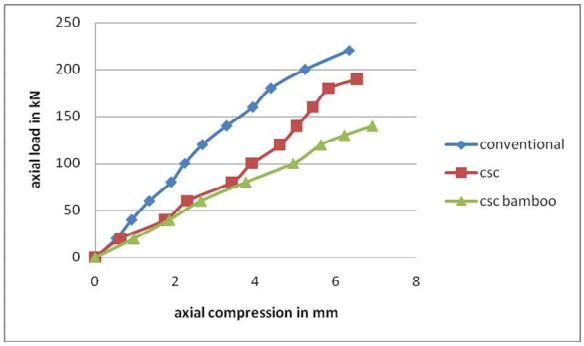

Figure 7: Comparison of load vs deflection for 1m length columns

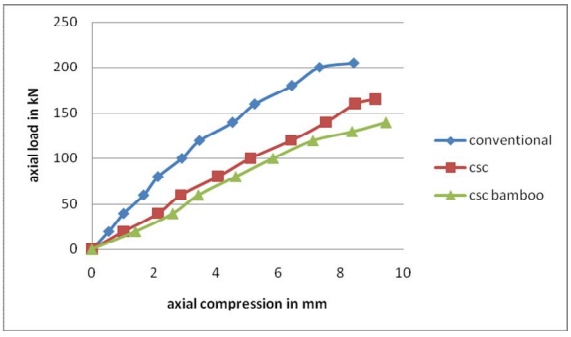

Figure 8: Comparison of load vs deflection for 1.15m length columns

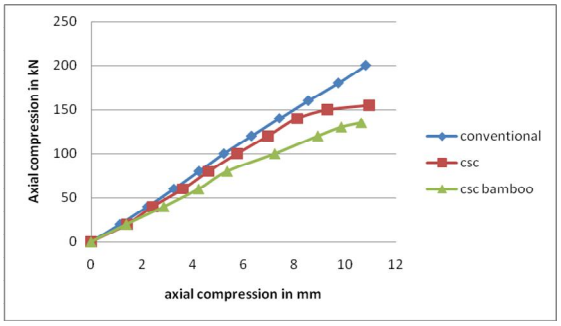

Figure 9: Comparison of load vs deflection for 1.3m length columns

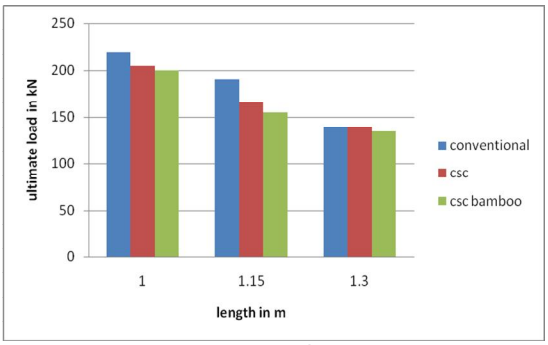

Figure 10: Comparison of ultimate load carrying capacity

Figure 11: Tested specimens

6. CONCLUSIONS

- Stiffness of the column decreased with the replacement of coarse aggregate.
- Stiffness of the column with bamboo reinforcement was lesser than the column with coconut shell aggregate and steel reinforcement.
- The ultimate load carrying capacity of the columns decreased with the increase in the length.
- The ultimate load carrying capacity for the column of 1m length with coconut shell aggregate and steel reinforcement was about 86% of the column with conventional aggregate and steel reinforcement and coconut shell with bamboo reinforcement was about 63%.
- The ultimate load carrying capacity for the column of

1.15m length with coconut shell aggregate and steel reinforcement was about 80% of the column with conventional aggregate and steel reinforcement and coconut shell with bamboo reinforcement was about 68%.

- The ultimate load carrying capacity for the column of 1.3m length with coconut shell aggregate and steel reinforcement was about 77.5% of the column with conventional aggregate and steel reinforcement and coconut shell with bamboo reinforcement was about 67.5%.

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