Flexural Behaviour of Light Weight Reinforced Concrete made with Agro Industrial Waste

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Abstract: In this present research inspection on the flexural performance of reinforced concrete members formed as Industrial waste. In the inspection, Palm Oil Shells (POS) are replacing in coarse aggregates (C.A). In this research, the lightweight concrete (LWC) is attained by substituting the coarse aggregates up to 50 percent employing Palm oil shells (POS). Replacing of C.A with POS in concrete making not individual solve the complexity of disposing of this solid misuse and also helps protect natural resources. To reduce CO₂ emissions from the cement industry, the cement is partially replaced with GGBS-ground granulated blast furnace slag and POFA - palm oil fuel ash, and adding 0.5% Glass fibers (G.F) to the volume of the concrete to increase ductility properties. Beams through varying dimensions were fictional and experienced under four-point bending and also Slabs with central load are considered. Data accessible includes deflection characteristics, Ductility Index. The investigation related to flexural actions of fiber-reinforced POS concrete be equivalent to the natural concrete and the new results compare sensibly fine with the Indian code of exercise.

Keywords: Flexural behaviour, reinforced concrete, Palm oil Shell concrete, lightweight, beams, and slabs

1. Introduction
In the precast industry, the major problem is lifting or transporting heavy load conventional structural elements one place to another place horizontally and vertically. For this equal capacity of machinery is required. To keep this in mind, the present investigation is varied out to decreasing the dead load of the structural elements, also to save the natural resources like gravel for future generations, and also utilizing the sustainable material for environmental safety. In this, the agriculture wastes being used in lightweight concrete production. For this, the POS which is disposing on the ground is using after some treatment. Also, to reduce the greenhouse gases from cement manufacturing the cement is in part replacing through mineral admixtures like GGBS and POFA are used and to add to the ductility behavior in concrete 0.5 percentage ECR Glass fibers are added to the volume of the concrete.

Flexural presentation of normal in addition to lightweight fiber reinforced concrete beam with varying fiber content (0 to 0.75%) with 0.25% increment². Shear behavior of PKS and NWC beams with and deprived of shear reinforcement, and too compared the experimental result with different theoretical code practices (ACI,
Coconut shell has been worn as CA in the making of concrete. The flexural behavior of reinforced concrete beam ended with coconut shell is analyzed and compared with the NWC. Palm kern shell, 10% silica fume, and 5% Fly ash to produced lightweight foamed concrete beams to know the structural behavior. Created under reinforced palm oil shell concrete beams with varying percentage of reinforcement (0.52 – 3.9%) for flexural behavior. In evaluation which the permissible deflections were designed by the lowest amount back up ration, was careful while 1.42 mm. The removal of the weft yarn is rightly compact the ratio of the fabric reinforcements through numerous study account on getting better the TRC in general behavior by the adding up of the chop fibers. Increase in the stiffness of R.C. two-way slabs with opening and strengthened by CFRP sheet by the second and fourth scheme, and reduced the deflection at the same stages of loading. The imminence of the investigational and the set factor results designate that tool can exist worn to sculpt the behavior of harden fibers reinforced elevated force own -compact concrete slabs in flexure and foresee the utmost freight transport competence as well. However, more tests on such slabs are obligatory. After all the previous studies, the present problem is formed with POS, GGBS and POFA are replacing up to 50% in C. A and Cement respectively.

2. Material Properties and Mix Design

2.1 Conventional Concrete: Ordinary Portland cement confirming to IS:12269 (with specific gravity 3.15), fine aggregates (Specific Gravity -2.66, Zone -II), Coarse aggregates (Specific Gravity -2.63), and portable water were used for controlled Reinforced Portland cement concrete (RPCC) test specimens.

2.2 Light Weight Concrete: was obtained by mixing different combinations of cement, GGBS (Specific Gravity -2.98), POFA (Specific Gravity -2.2), Fine aggregates, Coarse aggregates, and palm oil shells (POS -2.2 Specific Gravity). SNFC based Superplasticizer is used for all the mixes.

2.3 Mix Proportions: For this M - 30 grade concrete is designed with aggregates replacement with POS and cement is substituted GGBS and POFA with up to 50%. All the mechanical properties of above two mentioned concretes are calculated for 12- mix ids. The mix Ids with different percentages of replacements are presented in the table.

| MIX ID | Percentage Proportions (C: GGBS/POFA: C. A: POS: F.A) |
|--------|-----------------------------------------------------|
| CN      | Conventional Mix  | 1:0:3.52:0:2.03 |
| CNF     | Conventional + G F | 1:0:3.52:0:2.03 |
| POG1    | 10% POS + 10% GGBs | 1:0.11:2.84:0.14:1.82 |
| POG2    | 20% POS + 20% GGBs | 1:0.25:2.83:0.31:2.04 |
| POG3    | 30% POS + 30% GGBs | 1:0.43:2.83:0.53:2.33 |
| POG4    | 40% POS + 40% GGBs | 1:0.67:2.82:0.83:2.71 |
| POG5    | 50% POS + 50% GGBs | 1:1:2.82:1.24:3.25 |
| POP1    | 10% POS + 10% POFA | 1:0.11:2.82:0.14:1.81 |
| POP2    | 20% POS + 20% POFA | 1:0.25:2.8:0.31:2.01 |
| POP3    | 30% POS + 30% POFA | 1:0.43:2.77:0.52:2.28 |
| POP4    | 40% POS + 40% POFA | 1:0.67:2.75:0.81:2.64 |
| POP5    | 50% POS + 50% POFA | 1:1:2.72:1.20:3.1 |

3. Experimental programme

In the present research work, the flexural behavior of Lightweight reinforced concrete is studied from beams and slabs. These samples are made with lightweight aggregates are palm oil shells and to improve ductility 0.5% glass fibers to the quantity of the concrete are introduced. These samples are cast with different longitudinal and cross dimensions. All the samples are tested under gravity loading. The total load setup is shown in fig: 1 for both beams and slab specimens. After conducting preliminary tests (Mechanical Properties), it is concluded that the replacement up to 30% optimum. Form the All the test specimens of Dimensions and sample identifications
are presented in the table: 2. The reinforcement detailing for all samples and the longitudinal and cross-sectional dimensions are mentioned in fig: 1.

| Element | Sample ID | Dimensions (mm) |
|---------|-----------|-----------------|
| Beam    | S1        | 700 x 150 x 150 |
| Beam    | S2        | 1500 x 150 x 150 |
| Beam    | S3        | 1500 x 150 x 230 |
| Slab    | S4        | 1000 x 1000 x 100 |

All the beams and slabs are cast as per mix design quantities and left it for hardening. After 24-Hrs of casting specimens demoulded and kept for curing. All the Samples each category is cured under membrane. After 28- days of curing the entire 21- Beam and 3- slab samples are applied whitewash was observe the crack pattern while applying to load. After whitewash, all the specimens are marked for load and dial gauge placing. Then applied the loading under 4- point bending for beam and central point load for sabs. The dial gauge is located closely at mid-span of the specimen to compute the deflection under each increment loading.

4. Results and discussion

The following constraints are determined from the experimental investigations.

4.1 Mechanical Properties: The strength characteristics of the all 12 -mixes are calculated as per the Indian standards and those are presented fig:2. In this compressive, split, bending strengths and modulus of elasticity (E) are calculated. The E values are shown in Gpa and reaming all 3- strengths are presented in Mpa.
4.2 Load Vs Deflection curve: In this present investigation beams deformation is noted for each load increment and represented in the fig: 3. It is representing load application on the left lateral and the right lateral is showing the load Vs Deflection curves. All the P-Δ curves are representing the Load (N) at Y-Axis and the deflection (mm) is X-Axis for (N2 to G3) for 3-samples (S1 – S3). All the 21- Curves are observed as nonlinear.

Fig. 3 Detailing of all Specimens

4.3 Maximum Load Carrying capacity and Maximum Deflection: After P-∆ Curve development the maximum load for all beam samples are collected and presented in Fig:4. In this figure the 7 – mix id’s all shown in X-Axis the corresponding maximum load is shown in Y-Axis. From the fig: 5. It is observed that the ultimate load for the entire mix IDs increased from S1 to S3.
(a) S1 - 700 x 150 x 150

(b) P-Δ Curve

(c) S2 - 1500 x 150 x 150

(d) P-Δ Curve

(e) S3 - 1500 x 150 x 230

(f) P-Δ Curve

Load application on the slab

Crack pattern

Fig: 4 Testing of Slab panels on Loading Frame
the maximum deflection is noted for all 21 – samples are represented in fig: 6. In Fig: 6 all the 7 – Mix Id’s.

For the slab specimens the load maximum load carrying capacity and maximum deflection are presented in the one figure only, i.e. fig:7.

**4.4. Ductility index:** The ductility index is calculated for all the 21 – samples with the ratio of deflection at the ultimate stage to yielding point deflection. The ductility index is shown in Fig: 8.in the figure representing the all
7- mix ids at X-Axis and Y-Axis is representing the Index Ratio. The ductility index is observed more for the FRC beam (N2).

Fig:8 Ductility Index

5. Conclusions

Based on the experimental investigation carried out on the reinforced Palm oil shell concrete beams (RPOS) and conventional Portland cement concrete beams (RPCC), it can be concluded that:

- The load-deflection characteristics of the RPCC beams and RPOS beams are almost similar.
- The crack pattern for all 3 – samples (S1 to S3) is observed as same.
- The ultimate load haulage capacity of the lightweight beams is up to 20% of replacement is bearing the same as the conventional R.C.C Beams.
- The maximum mid-span deflection is observed for the 30% C.A replacement.
- The mid-span deflection is almost the same for 10% of C. A replacement as Normal concrete and then the deflection is decreasing by 20% C. A replacement, then deflection is increasing for 30% replacement.
- The ductility index value is decreasing from P1 to P3 but in G2 is showing maximum than G1 and G3.
- It is recommended that coarse aggregates replacement with POS for structural members up to 30%.
- All the lightweight fiber reinforced concrete (LWFRC) samples and fiber reinforced concrete (FRC) samples are behaving like a conventional Concrete.
- On or after the preliminary study it is observed that the palm oil shells are allowed to replace with coarse aggregates up to 30%.
- The all strengths are increasing from 10% to 20% but 20% to 30% is decreasing.
- The maximum load and minimum deflection are observed in the G1 concrete Mix next to the conventional concrete.

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