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# Fabrication Of Crumb Rubber Concrete 2D Frame Structure For Shake Table Test

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**Abstract:** *Reinforced cement concrete is prevailing construction materials for building of varieties of infrastructures worldwide. The demands on reinforced concrete aggregates (fine aggregate, coarse aggregate) are increasing day by day. Scrap tires are disposing and dumping in world in huge bulk. Accumulation of crumb rubber from tire scrap is dangerous and threatening to environment. As rubber is non-biodegradable and resistant to most natural environmental conditions, hence its direct disposal into environment or even burning in kiln creates lot of problems and environmental contaminations. Therefore, alternatives are required to get counteracted with the excessive demands on these ingredients. Researchers investigated experimentally crumb rubber concrete at different structural member levels i.e. beam, column, cylinders etc. and found reduced mechanical strengths while some parameters were improved upon testing. In current study two frames (plane frame) in 1/3rd reduced scale models meeting simple similitude requirements were constructed. One frame was of normal concrete and another one of crumb rubber concrete (incorporating 20% crumb rubber). The mix ratio used in superstructure for both models were 1:1.75:1.82 with water/cement ratio of 0.52 and 1:1.60:3.40 with water/cement ratio of 0.49 for foundation pads construction. Total twelve standard concrete cylinders were fabricated comprised three cylinders for each storey of normal concrete frame as well as of rubberized aggregate concrete frame model. Crumb rubber powders were incorporated and replaced fine aggregate by volume with 20%. The maximum size of coarse aggregate used in current study was 8mm.*

***Keywords****: Crumb rubber; Normal concrete; Frame construction; shake table; standard concrete cylinder.*

## "I. INTRODUCTION"

A structure fabricated in normal concrete incorporating some percent of crumb rubber is a type in which shredded rubber is partially incorporated to replace concrete aggregates. Crumb rubber is produced by reducing scrap tire down to sizes from 40 mesh to 3/8 inches and removing more than 99% of steel fibres and fabrics. Rubber has low density and non-biodegradable nature.  Incorporation of tire scrap crumb may be in fine or coarse nature. Alternate way of utilization is highly required to minimize excessive demands over aggregates (Mendiset al., 2017, Patel et al., 2015). Literatures have shown that excessive reduction in mechanical strengths occurred by replacing coarse aggregates in contrast to fine aggregates. The production and disposal rate of tire scrap is increasing enormously worldwide. Developing country like Pakistan facing more problems associated with tire scrap accumulation (Liu et al., 2016). Direct disposal or burning into kiln creates lot of problems (Khorami et al., 2015). From years these scrap tire rubbers are used for different works i.e. tile manufacturing, shoes, garden beds, bearing pads, concrete and so on. Researchers fabricated different structural member specimens i.e. beam, column and standard cylinders from rubberized aggregate concrete and explored the behaviors due to presence of shredded rubber in concrete (Xue et al., 2013, Youssf et al., 2015, Khaloo et al., 2008). In this study-work two plane frames were constructed the layout, dimensions and detailing are shown in Figure 1. Both frames were 2D and in reduced scale (1/3rd in this work). At each storey level slab of 2 inches in thickness with clear dimensions (3'-0"x5'-8") were constructed. To meet simple similitude requirements, on each floor level arrangements for two steel block weighing 600KG each were made. Six holes of 1-inch diameter were made on floor level for each steel block anchorage by threaded rod connections. Similarly, twenty-one holes of 1-inch diameter were made in foundation pad for firm and stiff anchorage of model over shake table by nut-bolt connections. Concrete cylinders were kept in water tank for 28-days while proper curing was done for 14-days by wrapping moist bags/clothes around all members of both models for desired strength achievement

## "II. MATERIALS"

For this work all materials were brought from locally available stock at district Peshawar, KP, Pakistan. The materials for this work were deformed steel bars, ordinary Portland cement, fine aggregate, coarse aggregate, rubber and potable water. These materials were checked and observed first to remove any objectionable debris, dust and impurities. Reinforcement bars were #1, #2, #3 and #4 for overall fabrication. Maximum size of coarse aggregate used was 8mm in this work. All materials were kept at construction site, Earthquake Engineering Center, University of Engineering & Technology, Peshawar, Pakistan.

## "III. METHODOLOGY"

Both models were fabricated very smoothly and in a polite way. Already available steel form-work shown in Figure 2 was used for pad and superstructure erection. #4 and #3 deformed steel bar were used for reinforcement in foundation pads. #4 reinforcement bars were provided as main longitudinal reinforcement, while #3deformed steel bar was used for stirrups in concrete pads. Detailing for concrete pad is shown in Figure 3. Steel fixer fixed all steel bars in concrete pad according to drawing. Twenty-one pvc pipes of 1-inch in diameter were provided at proper locations on concrete pads upto full length for making holes for threaded rod connections over shake table. For proper placement and removal of voids, open spaces, 1-inch concrete vibrator was used while concreting in foundation pads. After achieved sufficient strength for concrete pad, form-work including columns, beams and slab were erected as shown in Figure 4 for first storey construction. Inner surface of form-work was polished with mobile-oil for smooth concrete surfaces and easy removal of form-work. #2 deformed steel bar was used both in columns as well as in beams for longitudinal reinforcement, while #1 steel bar was used for stirrups in columns, beams and overall reinforcement for slab as shown in Figure 5. In reference with mix ratio for this study all ingredients were weighted for concrete batches for each storey shown in Figure 6. Using concrete mixer, all ingredients were fed in mixer and mixed first in dry condition appropriately. Special forma of steel as shown in Figure 7 was used to make holes in slabs at proper location for the purpose of nut-bolt connections for anchorage of steel block over slabs. Predetermined amount of potable water was fed in mixer and mixed all ingredients thoroughly for 2-3 minutes shown in Figure 8. While concreting, 1-inch concrete vibrator was used in columns, beams and in slab as shown in Figure 9 for satisfactory placement and compaction of concrete. After achieved sufficient strength form-work was removed and erected for 2nd storey over first one in a similar manner as done for first storey. Concreting of 2nd storey was done in similar way as for 1st storey construction as shown in Figure 10. Form-work was removed after achieved appropriate strength and was erected for 1st storey of 2nd model. The step-wise procedure for 2nd model was carried in a similar manner as for 1st model. The only difference in the construction of conventional concrete 2D frame model in contrast to crumb rubber concrete 2D frame model was the incorporation of crumb rubber from tire scrap by 20% as fine aggregate by volume. Crumb rubber was passed through sieve to remove rubber of large sizes and in flaky shapes as shown in Figure 11. Design considerations for this work are shown in Table 1.

### "A. STANDARD CONCRETE CYLINDERS FABRICATION"

During fabrication of each storey of both models three standard concrete cylinders were fabricated using standards procedure, cylindrical mould and tamping rod shown in Figure 06 & Figure 12. Each cylinder was casted by carrying standard ASTM test procedure. All cylinders were appropriately marked with permanent marker for identification purposes as shown in Figure 12. Concrete cylinders were kept in water tank for its complete wet curing for duration of 28-days. Concrete cylinders fabrication was done for the purpose of mechanical strengths investigation.

### "B. WHITE WASH"

Both models were white washed shown as in Figure 13 for the purposes of accurate identification and marking of all cracks in beams, columns, beam-column joints and in slab while carrying shake table test on both frame models.

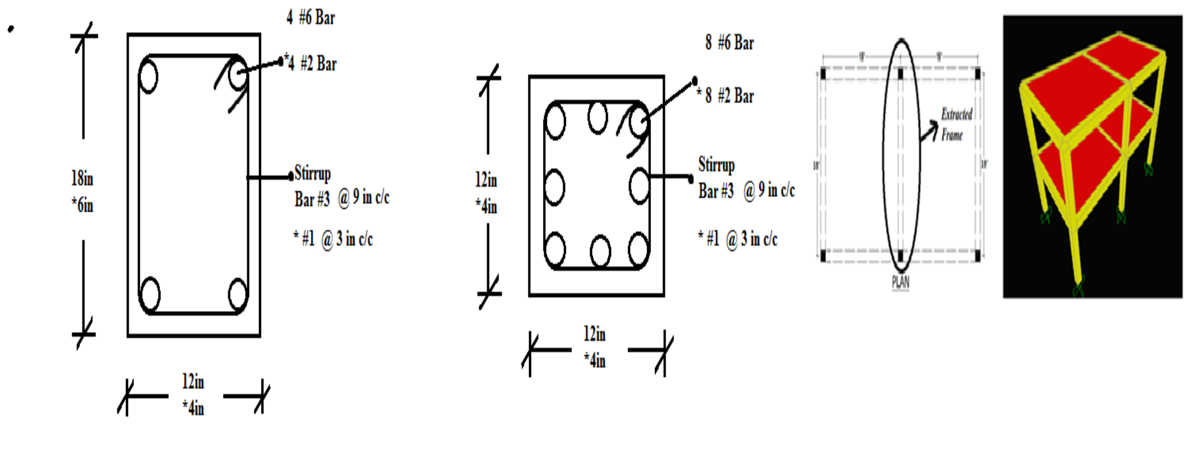


*Figure 1: Layout, Dimensions & Section detailing.*

*Figure 2: Steel form-work*

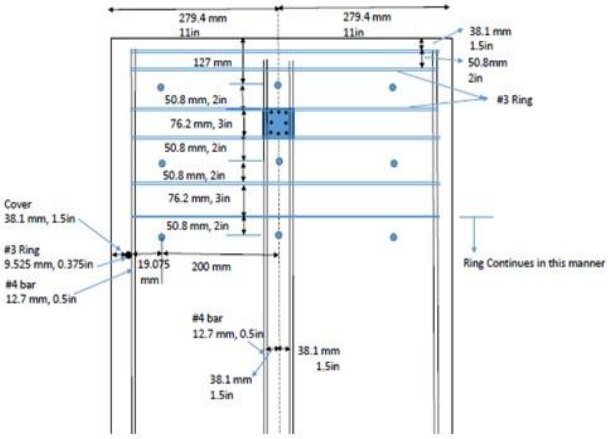


*Figure 3: Concrete pad*

*Figure 4: 1st storey form-work*

*Figure 5: Reinforcement of beams, columns & slab*

*Figure 6: Concrete ingredients*

*Figure 7: Forma for making holes in slab*

*Figure 8: Ingredients charged in mixer*

*Figure 9: Concrete Vibrator*

 

*Figure 10: 2nd storey form-work*

*Figure 11: Crumb rubber*

*Figure 12: Standard concrete cylinder*

*Figure 13: White wash*

***Table 1: Design consideration***

| Materials | Properties | Considered Values |
|---|---|---|
| Crumb Rubber concrete | CRC compressive strength, fc' | 2900psi |
| Steel | Steel Type | Grade 60, ASTM A615 |
| | Reinforcement Yield Strength, fy | 60 ksi |
| | Steel Modulus of Elasticity, Est | 29000 ksi |
| Site | Zone | (2B) |
| | Type | (Sb) |

## "VI. FUTURE WORK"

The already fabricated models and standard concrete cylinders will be shifted to concern testing laboratories for testing purposes available at, Earthquake Engineering Center, Department of Civil Engineering, University of Engineering & Technology, Peshawar, KP, Pakistan. Both models will be compared for expenditures incurred on and the seismic performance parameters after shake table tests.

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