Effects of Recycled Waste Tire Rubber as Coarse Aggregate on the Performance of Concrete

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Abstract : This study is the second throughout our studies on the sound absorption conduct of rubberised concrete in the sequence of writing papers. In India, there are really serious issues with waste tire disposal. So we have to find an environmentally friendly solution due to the extreme environmental problem related to the disposal of waste automotive tires. This study then investigates the consequences of reusing tire garbage in concrete applications by improving the characteristics of cement mix as a replacement material with a coarse aggregate to produce an ideal concrete mixture. In this research paper, the weight percentage of tire waste replacement with natural aggregate in the concrete mix is 0 percent, 10 percent, 20 percent, and 30 % respectively. As a coarse aggregate, the chipped form is usually square in shape and max. 20 mm in thickness. Tests conducted to get slump efficiency, flexural strength, measurement of density, control absorption of and M25 rubberised concrete mix.

***IndexTerms* – Rubberized concrete, Scrap rubber, chipped shape rubber, recycling, waste management.**

I. Introduction

Since last 2 decades in India, transportation vehicles have been increasing tremendously. Because of these difficulties and the resulting high costs, tire stockpiles have turned up across the country. These waste tires represent a significant environmental, human health, and aesthetic problem. Many of these problems contribute to the following:

(1) Toughness (difficult to break down and decompose), durability (difficult to process),
(2) Shape (large void space, poor space efficiency for storage and transportation)
(3) Volume (occupies a large volume).

Under this respect, the plentiful supply of scrap tire rubber should be used as a capable substitute for natural rubber compounds that would support the climate.

II. Aim of This Research

- Design a standard concrete mix (M25).
- Replacement of coarse aggregate of standard concrete mix with chipped shape scrap tire waste with wire by weight as 0%, 10%, 20%, and 30% respectively.

III. Experimental Work

i. **Materials Properties:** The raw materials used in performing the experiments included portland pozzolana cement, aggregate mixture (coarse and medium), sand , water, and tire waste. Light-vehicle tyres, such as motorcycles, were used.

ii. Cement: PPC of grade 43, conforming to Indian Standards (IS): 8112-1989 was used. Specific gravity of cement was found to be 3.15, Normal consistency was 32%, Initial setting time was 42 min and final setting time was 6hours.

iii. **Fine Aggregate:** The fine aggregate (Fig . 1) was 10 mm maximum natural sand, as seen in fig.1. Fine aggregate properties have been defined, and the sand properties are shown in table 1.

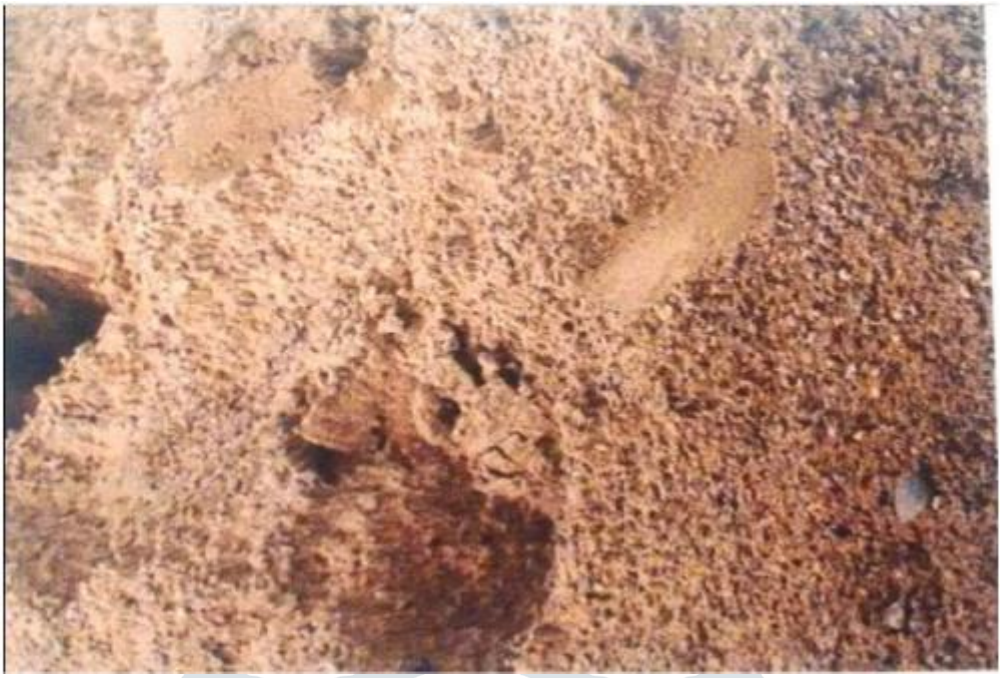

Fig.1- Fine Aggregate

Table: 1 Physical Properties of Fine Aggregates

Properties	Test Results
Specific Gravity	2.64
Fineness modulus	2.82
Water absorption	0 .98 %
Silt content	4.6 %

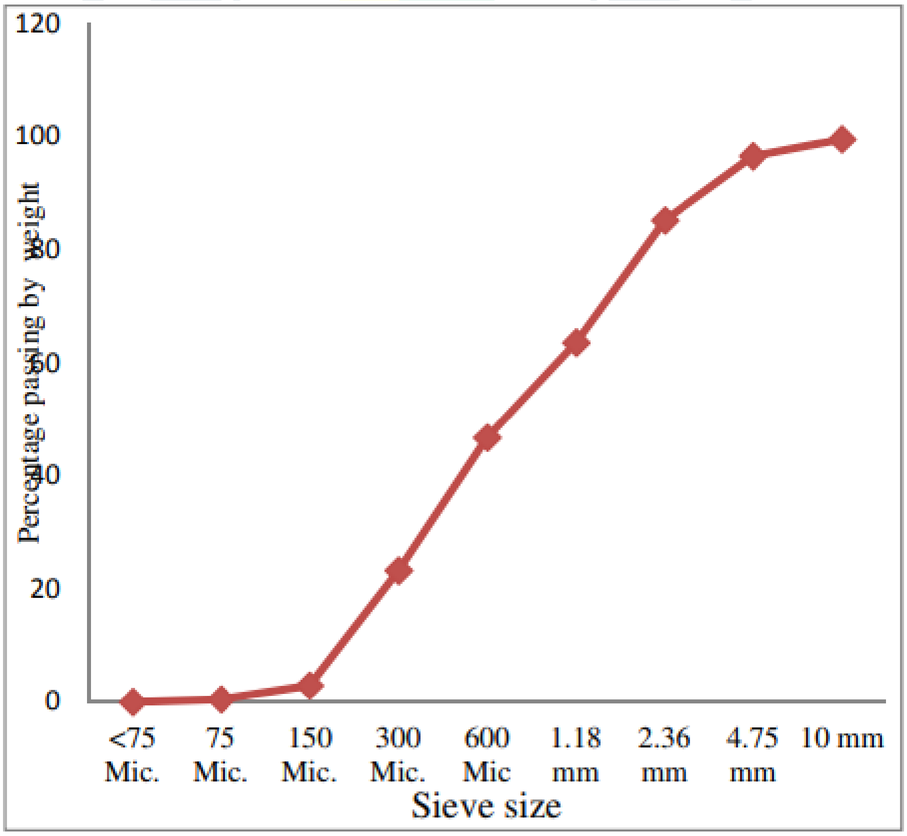

Fig: 2 Grading Curve

iv. **Coarse Aggregate:** Natural crushed stone aggregate for a maximal size of 20 mm as seen in fig.(3) The coarse aggregate's physical properties is calculated and tabulated in table (2).

Fig: 3 Coarse Aggregate

Table: 2 Physical Properties of Coarse Aggregate

Properties	Test Results
Specific Gravity	2.77
Water absorption of 20 mm Aggregate	0.94 %
Water absorption of 12.5 mm Aggregate	0.89%
Grading ratio of 20 mm to 12.5 mm	2:1

v. **Rubber Aggregate:** Waste tire rubbers generally square in shape and, chipped type obtained from local market with max size of 20mm without removing of steel wire was used as rubber aggregate shown in fig. (4) and rubber aggregate physical properties were described in table (3).

Table: 3 Physical Properties of Rubber Aggregates

Properties	Values
Type	Car scarp tire with steel wire
Shape of particle	Chipped type generally square in shape
Size	10-20mm
Specific gravity	1.40
Color	Black
Water absorption 24 Hours (%)	0.01

Fig: 4 Shape and Size of Aggregate

vi. **Concrete Mix Design :** Concrete performance is influenced by the properties of its components and the parameters of the formulation configuration influence concrete mixtures. The blend proportions of different types of percentages of substitute mixes and the amounts collected for mixes is tabulated as shown below in table (4).

Fig: 5 Concrete Mixture

Table: Control And Rubberized Concrete Mixtures And Sample Designation

Scrap tire %	W/C	Materials in Kg/m^3				
		C	W	FA	CA	RA
0	0.5	400	191.6	665.20	1188.20	N.A
10	0.5	400	191.6	665.20	1069.57	60.06
20	0.5	400	191.6	665.20	950.73	120.12
30	0.5	400	191.6	665.20	831.89	180.19

vii. **Test Specimen:** Cube specimens of 150 X 150X 150 mm were casted, The specimens were left in the moulds for 24 hour to attain enough strength so that it does not deform Be stripped, the specimens were placed in a curing tank after de-molding, and experiments were carried out at the conclusion of the healing process. Beam specimens were casted for flexural strength test and cured for 7 days. Both cubic and beam specimens were obtained on samples with rubberized concrete mixtures on 0%, 10%, 20%, and 30% replacement by weight and w/c ratio 0.5 is maintained. An average of the findings from three samples was obtained for each experimental parameter.

IV. Experimental Results And Discussion

The concrete's workability was assessed for evaluating fresh concrete directly after its manufacture in terms of slump according to IS Code. It is noted that slump has been fall off due to increase in percentage of rubber aggregates at same w/c ratio in control and all replaced samples of concrete mix. In control specimen, slump is seen to 92 mm and when the coarse aggregates are replaced with 30% tire chips then the slump is about 5 mm which becomes about zero slump value. Figure 6 shows the slum values at different values of scrap tyre rubber.

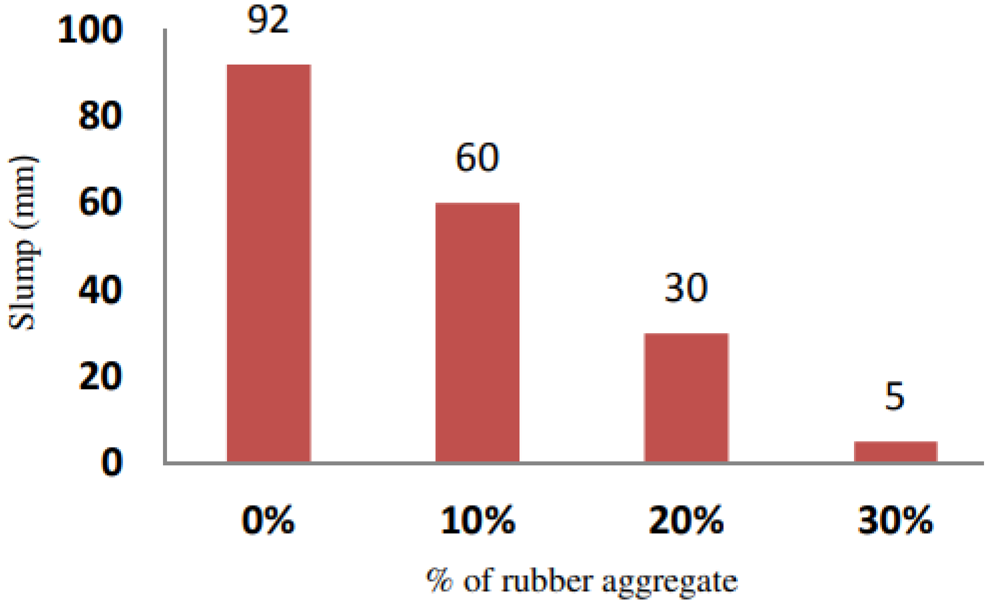

Fig: 6 Slump values for different percentage of rubber aggregate

Flexural resilience is the beam or slab's ability to withstand a bending loss. The fracture toughness test is conducted on beam specimens at 7days and 28days by an original question loading device as per IS: 516-1959.

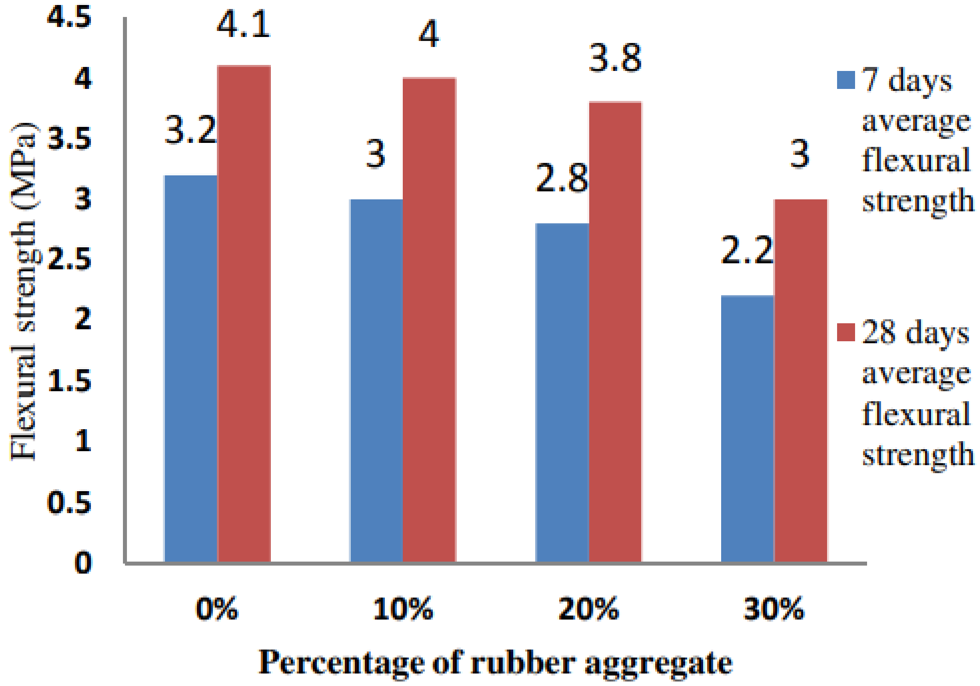

Fig: 7 Comparison of 7 days and 28 days average flexure strength for different percentage of rubber aggregate

Flexural resistance decreased by increasing tire rubber combined replacement. Variations in flexural tensile strength were obtained 7 days & 28 days as opposed to 0 percent, 10 percent, 20 percent and 30 percent rubber aggregate replacement. Extreme value 3.2 MPa of average flexural strength was found at 7 days with control mix at 0 percent rubber aggregate replacement and average flexural strength at 30 percent replacement was minimum value (2.2). Maximum value (4.1MPa) of average flexural strength was found 28 days with control mix at 0 percent rubber aggregate replacement and average flexural strength at 30 percent replacement was a minimum value 3 MPa. It was also found that the control experiments with a substitution of 0 percent rubber aggregate had a brittle failure and were split into two parts under load on the other hand the concrete with rubber did not have a failure of brittle type under loading method.

Density experiments were determine the dry density of freshly produced concrete samples according to IS: 2572. The constant w / c ratio and the volume of scrap rubber substitution had affected the densities. The density indicates a trend downward, as seen in fig. 8

The concrete density varied from 2505 to 22230 kg / m3, based on percentage of the rubber aggregate. The actual density of concrete blends replaced by 10 percent, 20 percent and 30 percent, respectively, decreased by 3.4 percent, 7.9 percent and 10.97 percent relative to concrete with control tests.

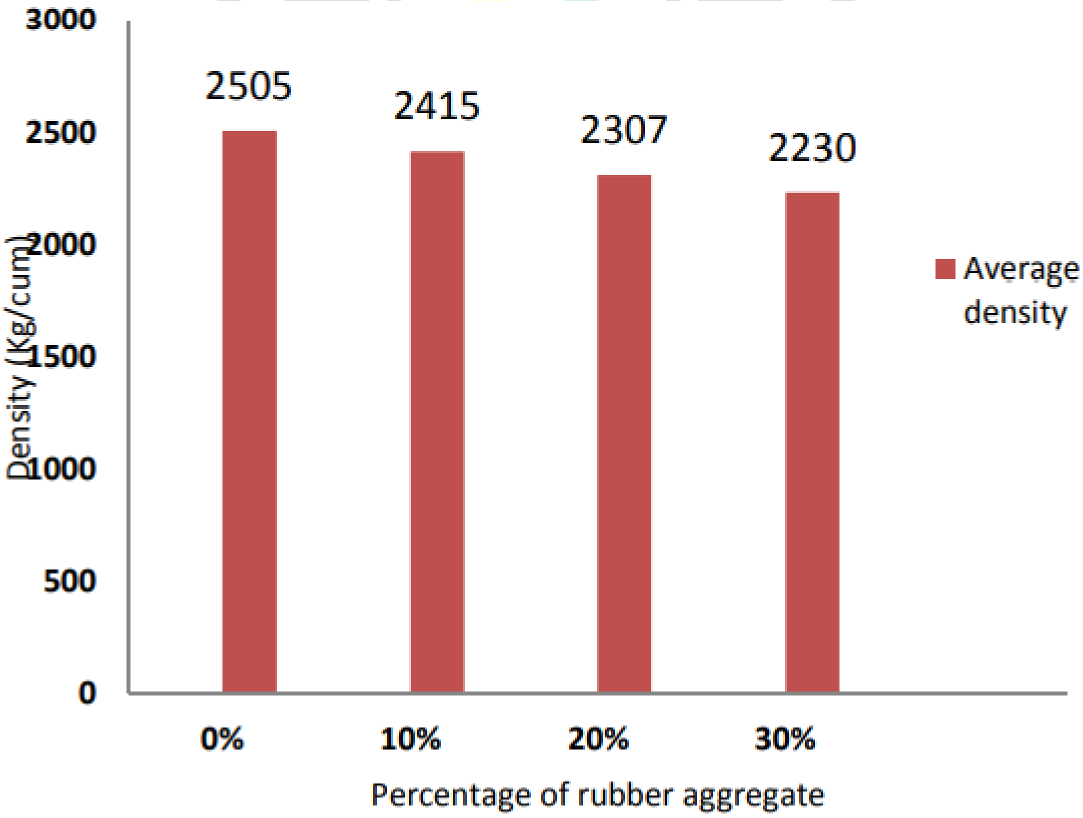

Fig: 8 Density calculation

ASTM C642-81 explains the method to determine water absorption in concrete. Cubes were casted and cured. Water absorption test carried out on concrete cubes and it was found that it will be increases by increasing the content of scrap tire rubber in place of coarse aggregate. Also, formation of internal voids due to rubber replacement causes water absorption. At the age of 28days, the amount of water absorption for control mix was found 1.22% as shown in figure 12. Percentage increase at 10%, 20%, and 30% replacement of rubber aggregate by control specimen was found 36%, 105% and 162% respectively.

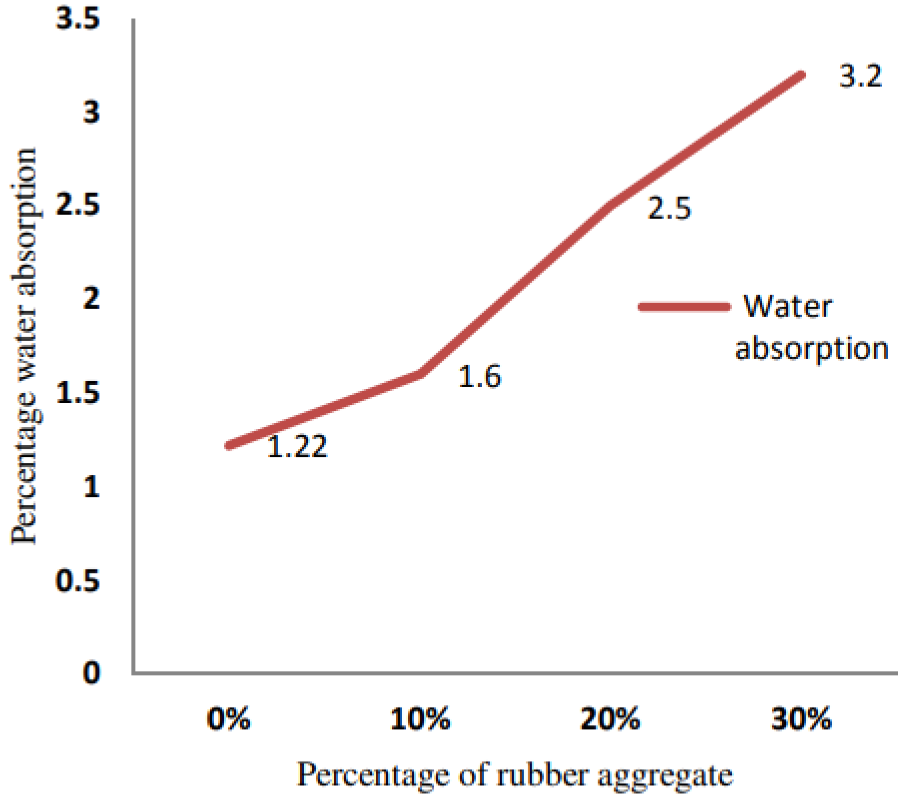

Fig: 9 Water absorption values for different percentage of rubber aggregate

VII. CONCLUSION

Based on the experimental investigation, the following can be concluded:

1. The study illustrate that it is possible to design rubberized concrete with varying percentage of scarp rubber by coarse aggregate such as 0%, 10%, 20%, 30%.
2. Higher content of waste tire rubber (chipped shape) produces the light weight concrete.
3. The addition of recycled rubber tyres into the concrete mix contributes to decreased slump and workability for the different tests of the mixture.
4. Minor decrease in flexural strength was observed on using waste rubber as coarse aggregate. The highest reduction was related to 30% replacement of rubber used. The reduction in flexural strength at 28 days of age was about 26.83%
5. Density declines as the amount of rubber combined increases, with various blend ratios. As percentage of rubber overall content decreases, the absorption of water increases. The basic gravity and bulk density of rubber aggregates were found to be less relative to normal coarse aggregates.

REFERENCES

[1]. Almaleeh, Abubaker M, Stanley M Shitote, and Timothy Nyomboi, "Use of Waste Rubber Tires as Aggregate in Concrete." 8(February): 11–19, 2007.

[2]. Waris, Muhammad B., Nehal N. Ali, and Khalifa S. AlJabri. "Use of Recycled Tire in Concrete for Partial Aggregate Replacement. International Journal of Structural and Civil Engineering Research, 5(4): 273–76 2016.

[3]. Mohsin, Ali I, and Besma M Fahad, Improve the Acoustic Impedance and Thermal Conductivity of Mortar by Adding Recycled Rubber, 5: 9–16, 2015.

[4]. Holmes , Niall, Alex Browne, and Christopher Montague, Acoustic Properties of Concrete Panels with Crumb Rubber as a Fine Aggregate Replacement. Construction and Building Materials, 73: 195–204, 2014.

[5]. Torgal, F Pacheco, A Shasavandi, and S Jalali, "Tire Rubber Wastes Based Concrete: A Review." WASTES: Solutions, Treatments and Opportunities: 1st international confreance, 2011.

[6]. Sukontasukkul, Piti, Use of Crumb Rubbe r to Improve Thermal and Sound Properties of Pre-Cast Concrete Panel. Construction and Building Materials 23(2): 1084– 92, 2009.

[7]. Fotini Kehagia and Sofia Mavridou, Noise Reduction in Pavement Made of Rubberized Bituminous Top Layer. Open Journal of Civil Engineering, 4, 198-208, 2014.

[8]. Boudaoud, Zeineddine, and Miloud Beddar,"Effects of Recycled Tires Rubber Aggregates on the Characteristics of Cement Concrete." 2012(December): 193–97, 2012.

[9]. Journal, British, Environmental Sciences Vol, European Centre, and Development Uk, "1 , 2 1." 4(4): 11–18, 2016.

[10]. Khan, Mohd Kashif, and Bhanu Pratap Singh, "Used Of Recycled Tire / Rubber as Course Aggregate and Stone Dust As Fine Aggregate in Cement Concrete Works." 12(5): 101–7, 2015.

[11]. Kumar, G Nagesh, V Sandeep, And Ch Sudharani, “Using Tires Wastes As Aggregates In Concrete To Form Rubcrete – Mix For Engineering Applications.” (2004): 500–509, 2014.

[12]. Abas, Falak O, Enass A Abdul Ghafoor, Mohammed U Abass, and Talib Kamil Ab, Re Use of Waste Tires Rubber As Fine Aggregate Replacement in, 4(3): 110–20, 2015.