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Evaluation of Modulus of Elasticity for Recycled Coarse Aggregate Concrete

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Abstract-Modulus of elasticity of concrete is a very important property to determine the deflection of the structural elements. Within the scope of this study, different concrete mixtures were produced to determine the influence of aggregate derived from demolished concrete structures. Deflection of concrete beams and slabs is a common building movement. The modulus of elasticity testing is used to determine the deflection of the concrete specimens that having different percentage of recycled aggregate replacement. The testing is just carried out after 28 days of casting. The resting specimen was 100mm diameter and 200 mm height. There were total of six batches of concrete mixes, consists of every 20% increment of recycled aggregate replacement from 0% to 100%.

Key Words-Recycled Aggregate, Modulus of Elasticity, Deflection.

I. INTRODUCTION

The major challenges of our present society are to protect the environment. Some important elements are to reduce the consumption of energy and natural raw materials. This research is getting considerable attention under sustainable development nowadays. The use of recycled aggregates from construction and demolition wastes is showing positive application in construction as alternative to natural aggregates. It conserves natural resources and reduces the space required for the landfill disposal. In order to determine the effect of this recycled aggregate on Modulus of Elasticity of concrete, different concrete mixtures were produced. The test samples differ in the type and amount of the aggregate. As reference, a concrete sample containing 100% natural dense aggregate was used. In different aggregate mixtures, the natural dense aggregate was partly replaced by recycled aggregate. The experience shows, that in general the Modulus of Elasticity from concrete made of recycled aggregate is lower than the modulus of elasticity of concrete made with natural dense aggregate. The research of this study is to investigate the Modulus of Elasticity of concrete made with recycled aggregate.

II. PERFORMANCE OF TESTS

A. Composition Of Concrete

Aggregate: The marking of the samples is related to the material composition of the mixture and is listed in Table 1.

Table 1: Tested Samples

Sr. No.	Mix	Recycled coarse aggregate
M20	Mx1	0 %
	Mx2	20%
	Mx3	40 %
	Mx4	60 %
	Mx5	80 %
	Mx6	100%
M25	My1	0 %
	My2	20 %
	My3	40 %
	My4	60 %
	My5	80 %
	My6	100 %
	Mz1	0 %
	Mz2	20 %



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M30	Mz3	40 %
	Mz4	60 %
	Mz5	80 %
	Mz6	100 %

B. Mix proportions

All concrete mixtures had the following mix proportions:

Table -2 Concrete Mix Proportions

w/c ratio	Proportion	Cement (kg/m ³)	Sand (kg/m ³)	Coarse Agg. (kg/m ³)	Water (kg/m ³)
0.55	1:2.06:3.87	327	679.25	1265.5	180
0.5	1:2.12:3.46	360	763.51	1245.73	180
0.45	1:1.87:3.06	400	751.6	1226.3	180

As the mix proportion of all different concretes are constant, a change in Modulus of Elasticity is only caused by the different % replacement of natural aggregate.

C. Specific data of the recycled coarse aggregate

In the Tables 3 the measured Fineness modulus, Specific Gravity, Impact value (%) and Density (Kg/m³) of the recycled aggregate used are shown.

Table -3 Properties of Aggregates

Property	Recycled Coarse Aggregate
Fineness modulus	7.476
Specific Gravity	2.74
Impact value (%)	12.92
Density (Kg/m ³)	1660.44

D. Storage of the test samples

After casting, the samples (cylinders, diameter = 100 mm, height = 200mm) were led in the moulds for 24 hours, stripped and cured in water until the age of 28days.

E. Testing the Modulus of Elasticity: (IS 516 – 1959)

Modulus of elasticity of concrete is a very important property to determine the deflection of the structural elements. Deflection of concrete beams and slabs is a common building movement. It also mentioned that the deflection is the result of the flexural strains that develop under dead and live loads and this may occur cracking in the tensile zone. The modulus of elasticity testing is used to determine the deflection of the concrete specimens that having different percentage of recycled aggregate replacement. The testing is just carried out after 28 days of casting. The resting specimen was 100mm diameter and 200 mm height. The Modulus of Elasticity can be calculated by the difference of the measured stresses and strains on an upper level (i.e. 1/3 of the value of compressive strength) and a lower level (i.e. 0.5 N/mm²).

Fig 1 shows the setup of Modulus of Elasticity.



Fig 1: Setup of Modulus of Elasticity

III. RESULTS

The results of the measurement are shown in Table 4.

Table 4 Result of Modulus of Elasticity

Mix Type	Modulus of Elasticity (MPa)
Mx1	22982
Mx2	22282
Mx3	20372
Mx4	20690
Mx5	23555
Mx6	16297
My1	24828
My2	24955
My3	21709
My4	19799
My5	23300
My6	17762
Mz1	24510
Mz2	22218
Mz3	22918
Mz4	21645
Mz5	22409
Mz6	22664



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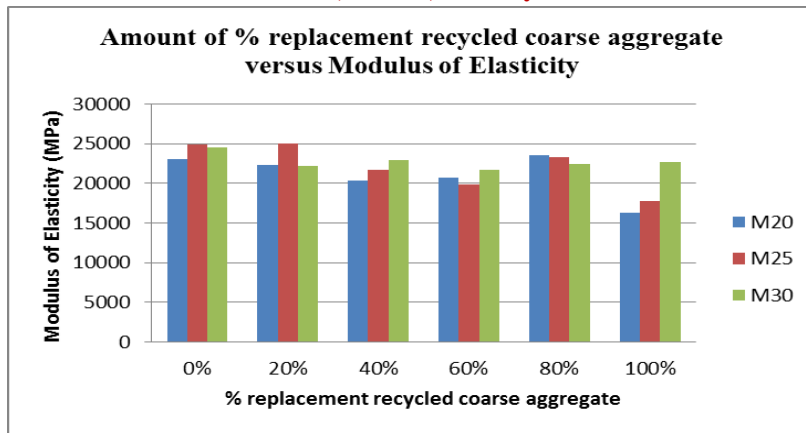


Fig. 2: Amount of % replacement recycled aggregate versus Modulus of Elasticity

IV. CONCLUSION

Based on limited experimental investigation concerning the modulus of elasticity of concrete, the following conclusions are drawn:

- In general, Modulus of elasticity decreases with % replacement of natural aggregates.
- For M20 concrete only 80% replacement of natural aggregates the Modulus of elasticity increases.
- For M25 concrete only 20% replacement of natural aggregates the Modulus of elasticity increases.
- For M30 concrete % replacement of natural aggregates is increases the Modulus of elasticity decreases.
- Use of recycled coarse aggregates in concrete can save the disposal costs and produces a 'greener' concrete for construction.
- This research concludes that recycled coarse aggregates can be used as Construction Material.

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