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Waterproofing of roof with discarded tyre rubber crumb powder

Pro. Syed Sohailuddin[1], Juned Turak[2], Prathimesh Wagh[3]

[1](Assistant Professor, Anjuman College of Engineering And Technology, Nagpur
Email: sohailsyed111@gmail.com)

[2] (Civil, Anjuman College of Engineering And Technology, Nagpur
Email: junedturak@gmail.com)

[3] (Civil, Anjuman College of Engineering And Technology, Nagpur
Email: prathimeshwagh642@gmail.com)

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Abstract:

The main aim of this research is to analyse the feasibility of recycled rubber tires for use in the field of construction. It aims to find a rubber-concrete mixture using recycled rubber tire crumbs that can enhance the waterproofing capacity of concrete.

Keywords — **Waste tire rubber crumbs, concrete, rubecrete, water absorption, compressive strength, workability.**

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I. INTRODUCTION

About one crore 10 lakhs all types of new vehicles are added each year to the Indian roads. The increase of about three crores discarded tyres each year pose a potential threat to the environment. Tyres are recycle yet significant number are added to existing tyre dumps or landfills. The generation of waste tyres far exceeds than now being recycle. Waste rubber tyres cause serious environment problems all over the world. These accumulated waste materials can be used in Civil Engineering Construction.

Early studies on the use of worn out tyres in asphalt mixes were very promising, not much attention has been given to the use of rubber from scrap tyres in Portland cement concrete.

II. TYRE CRUMB

Crumb rubber may be produced by an ambient process (mechanical sizing) or by cryogenic process (freezing). In the mechanical process, tyres are reduced to chips or shreds and then put through granulators which separate and remove loose steel and fiber and further reduce rubber particle size. Finally, the small rubber chunks are ground to produce rubber crumb of 30 to 80 mesh size. In the cryogenic process, tyre chips are frozen in liquid nitrogen as they pass through a cryogenic tunnel then broken down by impact. They then pass through a series of screen meshes where they are shattered into their three component parts: rubber, steel and fabric. Although the cryogenic process is the more expensive of the two, it produces smoother and smaller crumb.

TYRE CRUMB

III. IMPORTANCE OF THE STUDY

Rubber tire wastes were already used in making asphalt mixes for paving roads and other related construction works. The rubber properties such as its density, moisture absorption, and thermal insulation were factors that make it a good material for water proofing as well as for insulation benefitting the construction industry. Also, the study utilized waste materials which help in conserving our environment. This can benefit the community due to the fact that rubber tire crumbs are cheaper than other aggregates and sometimes they can be obtained at no cost at all. Because of lighter mass in the concrete mixture, when rubber tire crumbs were used, the weight of the structure would be reduced at the same time.

IV. METHODOLOGY

A. *Collection of raw materials*

1. Cement: OPC 53 Grade conforming to IS: 8112-1989
2. River Sand: Collected from Jain sand suppliers
3. Tyre rubber crumb powder: Procured from tyre recycling industry in khapa, where the material is available in bulk quantity.

B. *Testing on materials*

CEMENT:

i. Initial and final setting time
ii. Consistency test
iii. Strength test

AGGREGATES:

i. Specific gravity
ii. Water absorption
iii. Impact value
iv. Flakiness index
v. Abrasion test

SAND:

i. Specific gravity
ii. Bulking of sand
iii. Silt content test

C. *Mix design*

Mix design is defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. Generally we are using M20 grade of concrete for better result.

- **Quantity of material used for Conventional Concrete Cubes**

Weight of cement = 5160gm
Weight of sand = 7725gm
Weight of aggregate = 15480gm

- **Quantity of material used for rubberish Concrete Cubes with 3% crumb replacement of fine aggregate**

Weight of cement = 5160gm
Weight of sand = 7493.25gm
Weight of crumb = 231.75gm
Weight of aggregate = 15480gm

- **Quantity of material used for rubberish Concrete Cubes with 1% crumb replacement of fine aggregate**

Weight of cement = 5160gm
Weight of sand = 7647.75gm
Weight of crumb = 77.25gm
Weight of aggregate = 15480gm

V. TESTING RESULTS

1. *CEMENT*

- Initial setting time and final setting time = 70 min and 180 (initial setting time should be more than 30 min and final setting time should be less than 600 min)
- Consistency test = 29 % range (25-35 %)
- Strength test = 23 mpa for 7 days (range 20 – 22%)

2. *AGGREGATES*

- Specific gravity = 2.85 range (2.5 to 3.0)
- Water absorption =1.2 % (it should not exceed 3%)
- Impact value =7.85% (it should be less than 45%)

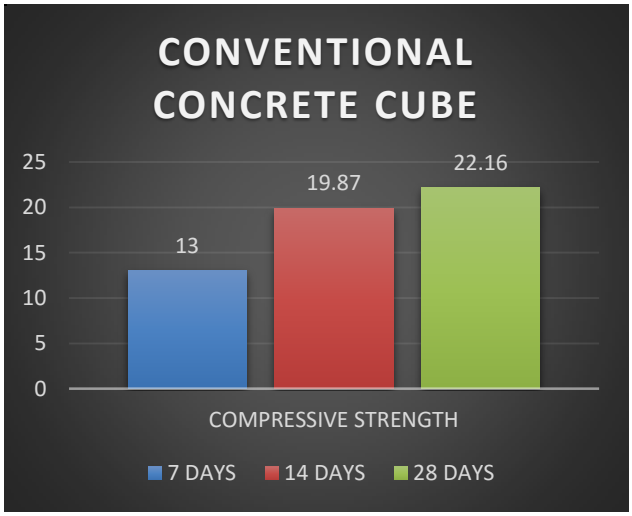
- Flakiness index = 8.56% (it should be less than 35%)
- Abrasion test = 9.5 % (it should be less than 18 %)

All the values are within limit so we can use the aggregates.

3. *SAND*

- Specific gravity = 2.66 % (it should be around 2.65 to 2.67)
- Bulking of sand = 13.55 % i.e., moisture content 2.6 % (excessive moisture content increases the workability but loses its strength)
- Silt content test = 3.77 % (it should not exceed 8%)

After performing all the experiments on various materials and all the values are within limit therefore our material is suitable for further use.



4. *COMPRESSIVE STRENGTH*

Fig. 1 Compressive Strength of Conventional Concrete Cubes.

Fig. 2 COMPRESSIVE STRENGTH OF RUBBERISHED CEMENT CONCRETE CUBES WITH 3% REPLACEMENT OF SAND

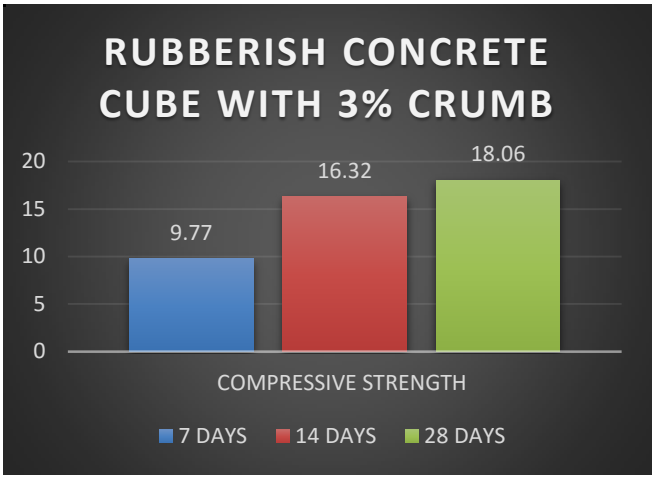


Fig. 3 COMPRESSIVE STRENGTH OF RUBBERISHED CEMENT CONCRETE CUBES WITH 1% REPLACEMENT OF SAND

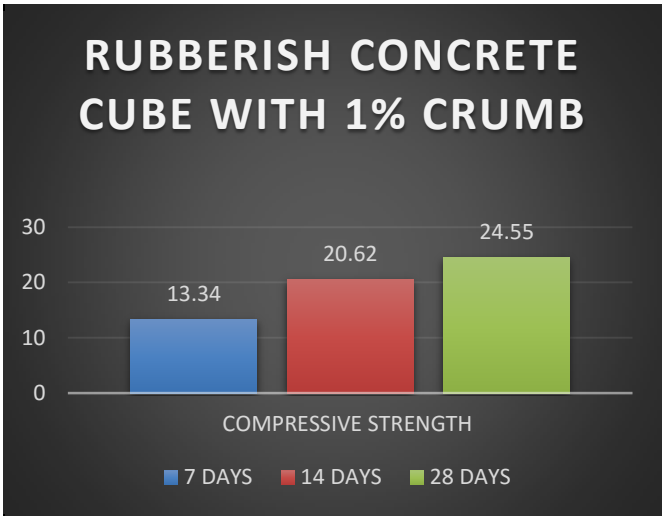
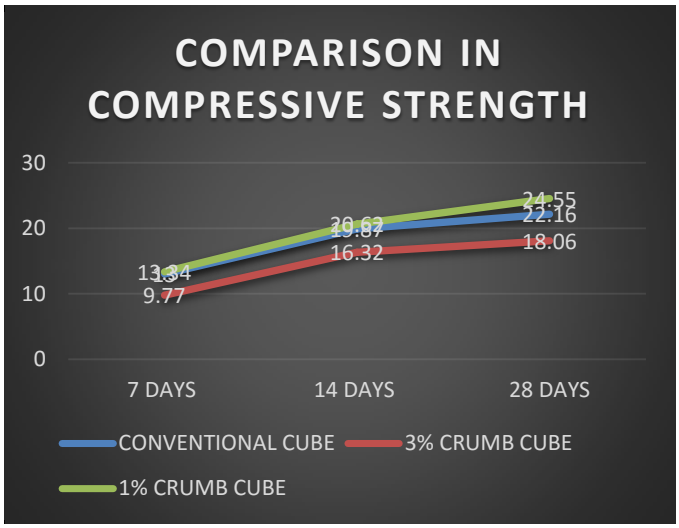


Fig. 4 COMPARISON



From the comparison chart it was observed that strength was increase by 9.74% with replacement of 1% of crumb rubber to the fine aggregate in concrete. But, compressive strength was reduced by 18.5% with replacement of 3% of crumb rubber to the fine aggregate in concrete respectively.

VII. WATER ABSORPTION TEST

TABLE 1: **TRIAL 1**

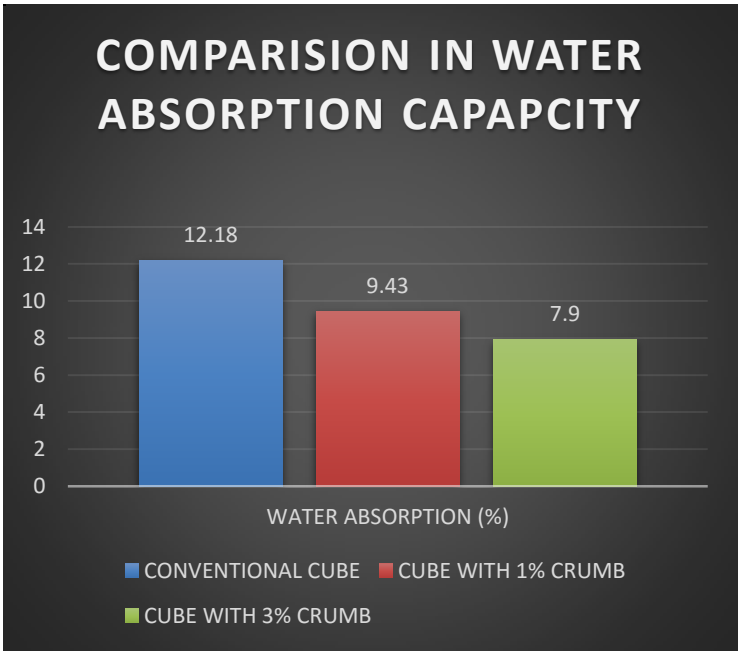
SPECIMEN	CRUMB (%)	Oven Dry Mass (kg)	Dry Mass (kg)	Water Absoption (%)
1	0%	2.323	2.60	11.94
2		3.376	2.642	11.2
3		2.134	2.42	13.42
AVERAGE				12.18

TABLE 2: **TRIAL 2**

SPECIMEN	CRUMB (%)	Oven Dry Mass (kg)	Dry Mass (kg)	Water Absoption (%)
1	1%	2.309	2.55	10.44
2		2.289	2.51	9.65
3		2.181	2.36	8.2
AVERAGE				9.43

TABLE 3: **TRIAL 3**

SPECIMEN	CRUMB (%)	Oven Dry Mass (kg)	Dry Mass (kg)	Water Absoption (%)
1	3%	1.983	2.152	8.02
2		1.843	1.995	8.25
3		1.855	1.993	7.44
AVERAGE				7.9



From the above results it shows that concrete incorporated with rubber tire crumb powder has a lower water absorption than ordinary concrete mix. The specimen with the lowest water absorption was the one in which we replace 3% crumb to fine aggregate which had a water absorption rate of 7.9% which is less than the conventional cube with water absorption rate of 12.18%.

VIII. BENEFITS

Advantage of this treatment:

a) Utilization of waste material.
b) All materials are easily available.
c) Having lower density, it reduces load on roof.
d) Flexible materials which does not crack.

IX. CONCLUSION

From this experiment, the following conclusions could be drawn:

1. Recycle rubber tire crumbs be used as partial replacement of aggregated which can reduce the water absorption, permeability of concrete which can make it waterproof.
2. The design mixture having lower absorption than conventional concrete that is normally used in the construction industry but higher rate of absorption than commercial concrete with waterproofing chemical admixture. It has potential for waterproofing but concrete with admixture shows greater reduction of rate of absorption as well as permeability and strength.
3. Rubber concrete mixture has the lowest rate of absorption among the design mixes provided by the researchers. Compared to normal concrete that is conventionally used in the construction industry, has lower rate of absorption. But then, compared to commercially used concrete for waterproofing incorporated by a chemical admixture, it has higher rate of absorption than that.
4. Rubber concrete has a potential of reducing concrete's water absorption as well as permeability.

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