# Production of Pervious Concrete Using Waste Rubber Crumbs as A Partial Replacement of Coarse Aggregate

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**Abstract - Pervious concrete is a type of lightweight concrete that is porous, obtained by detaching sand from the normal concrete mix, therefore it really known as a no-fine concrete. The advantage of this type of concrete are lower density, less cost due to lower cement content and no use of fine aggregate. Pavements porous concrete is a noble structure design in the urban management development generally enabling water to be permeated within its structure. It has also capable in the same time to cater dynamic loading. Developing pavement materials by using rubber aggregate is an effective approach to massively utilize waste tires. Due to the negative effects that derive from large impervious surfaces in urban areas, pervious concrete has been developed, and has become an environmentally friendly pavement material. As a porous and permeable material, pervious concrete presents an overwhelming advantage in solving urban problems, such as flooding, groundwater decline, urban heat island phenomena, etc. Waste crumb rubber has been verified as a feasible modifier for pavement material. Permeability, compressive strength, workability, are tested. The results indicate that the addition of rubber slightly decreases strength and permeability, but significantly enhances ductility and freeze- thaw resistance. Fine crumb rubber with a suitable incorporation level could remarkably improve the ductility and freeze–thaw resistance of pervious concrete without sacrificing excessively strength and permeability.**

**Keyword: Pervious concrete, Permeable concrete, pervious concrete using crumb rubber, pervious concrete using waste materials.**

## I. INTRODUCTION

Concrete is a widely employed construction material globally, retaining its position as a favoured and affordable option. This can be attributed to its numerous advantages, such as versatility, adaptability, formability, and cost-effectiveness. While concrete possesses high compressive strength, durability, and workability, its tensile capacity is rather limited. Conventional concrete may result in honeycombs, inadequate consolidation in thin sections, or congested reinforcements, compromising the strength and durability of the structural elements. To construct strong and durable structures, it is critical to improve the performance of concrete. Lightweight concrete mixture is made with a lightweight coarse aggregate and sometimes a portion or entire fine aggregates may be lightweight instead of normal aggregates. It is convenient to classify the various types of lightweight concrete by their method of production. These are:

- By using porous lightweight aggregate of low apparent specific gravity, i.e. lower than 2.6. This type of concrete is known as lightweight aggregate concrete.
- By introducing large voids within the concrete or mortar mass; these voids should be clearly distinguished from the extremely fine voids produced by air entrainment. This types of concrete is variously knows as aerated, cellular, foamed or gas concrete.
- By omitting the fine aggregate from the mix so that a large number of interstitial voids is present; normal weight coarse aggregate is generally used. This concrete as no-fines concrete.

Pervious concrete is also known as porous concrete, permeable concrete, no fines concrete and porous pavement, it is a particular type of concrete in which concrete flatwork utility allows rain water to pass directly, thereby reducing runoff from a site and allowing groundwater recharge. Pervious concrete is a mixture of cement with coarse aggregate and water with no fine combination or very small aggregates. Pervious concrete allows 50% infiltration while impermeable concrete allows only 15%.

### A. Pervious Concrete

Pervious concrete (also called porous concrete, permeable concrete, no fines concrete and porous

pavement) is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge. Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. Pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways, and greenhouses. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to protect water quality.

Fig 1 Pervious Concrete

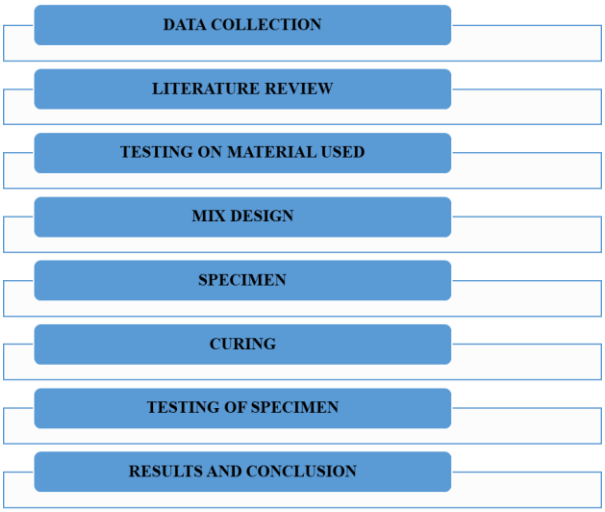
**B. Crumb Rubber**

Crumb rubber is defined as the coarse pieces of rubber obtained from vehicle tires. This type of rubber is obtained by a process called Ambient Grinding. This type of grinding is a multistep process and uses car or truck tires in the form of shred, or sidewalls, chips, or treads. By following the process, the rubbers, metals and textiles are separated out sequentially. After this, the tires are passed through a shredder, where the tires are broken into smaller chips. The small chips are then supplied into a granulator that breaks them further into even more smaller pieces while removing steel and fibre in the process. A very large amounts of used rubber tyres cumulate in the world every year out of which 275 million in the India and around 180 million in European Union. One of the most popular methods to get rid of this rubber waste is to pile these tyres in landfills, and since they have low density and poor degradation, we cannot burry them as landfills. These tyres are also placed in a dump or disposed of by simply piling them in large holes in the ground. And these dumps serve as a great homage to mosquitoes and these mosquitoes spread many diseases, this becomes a serious & dangerous health hazard. However, this rubber waste's higher amounts can be utilized as fuel, pigment soot, in bitumen, roof and floor covers etc. One of such applications that could use old rubber tyres effectively is rubberized concrete. Concrete can be made cheaper by replacing a fixed percentage of coarse aggregate with granulated rubber crumbs from rubber waste. These granulated rubber crumbs can be achieved through a process called continuous shredding, which is done to create crumbs small enough to replace aggregates as coarse as gravel effectively. Such kind of concrete can be used in manufacturing process of reinforced pavement and bridge structures because this has better resistance to frost and ice thawing

Fig 2 Crumb Rubber

## II. METHODOLOGY

Preliminary investigations such as concrete structures, coarse aggregate, and fine-grained collection, as well as the process of various inspection processes in accordance with IS codes for the detection of these structures and the mixing parameters obtained from compounding, were discussed in this regard.



A. Problem Statement

The materials used in the present work are Ordinary Portland Cement (OPC 53 Grade), coarse aggregate and Waste Crumb Rubber. For this project Ordinary Portland Cement having 53 Grade also known as (OPC 53 Grade) is selected. As per IS 4031-1988 if the strength of the cement is not achieved less than 53 N/mm2 then it is known as 53 Grade cement.

After proper mixing of the concrete the specimen will be casted in two shape i.e. cubes and cylinder. The cube will be of size 150mm x 150mm x 150mm and cylinder will be of size 150mm x 300mm. Below table shows the details of the specimen to be casted

Table 2 Details of Specimen

| Grade of Concrete | Percentage Replacement of Aggregate (Replacement in %) | No of Cubes | No of Cylinders |
|---|---|---|---|
| M20 | 0 | 5 | 5 |
| | 10 | 5 | 5 |
| | 20 | 5 | 5 |
| | 30 | 5 | 5 |
| | 40 | 5 | 5 |

## III. TESTING ON SPECIMEN

A. Density of concrete

Table 3 Results For Density of concrete

| Percentage Replacement | M0 | M1 | M2 | M3 | M4 |
|---|---|---|---|---|---|
| M20 (Kg/m$^2$) | 2520 | 2470 | 2420 | 2372 | 2324 |

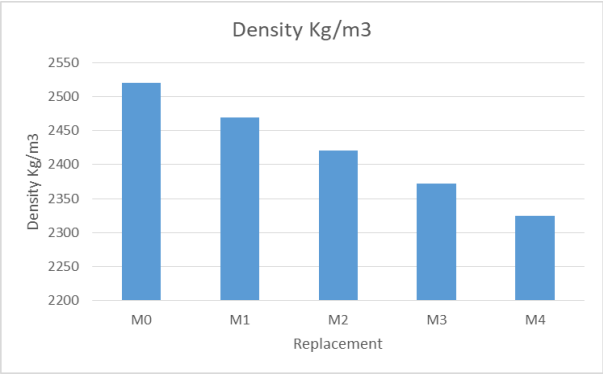



Fig 3 Density of concrete

The density of grade OPC M20 decreases with the increase in percentage replacement of Rubber Crumbs as aggregate the Rubber Crumbs is light in weight than aggregate. Hence Rubber Crumbs concrete can be considered as light weight concrete which results in smaller dead loads. As compare with M0 And M4 it have almost difference of 190 Kg/M3 that means 1.5 Kn Dead Load per M3.

B. Compressive Strength

Table 4 Compressive Strength

| Rubber Crumbs % | 7 days | 28 days |
|---|---|---|
| 0% | 18.6 | 28.62 |
| 10% | 19.68 | 29.82 |
| 20% | 21.72 | 33.41 |
| 30% | 22.8 | 35.99 |
| 40% | 19.39 | 29.82 |

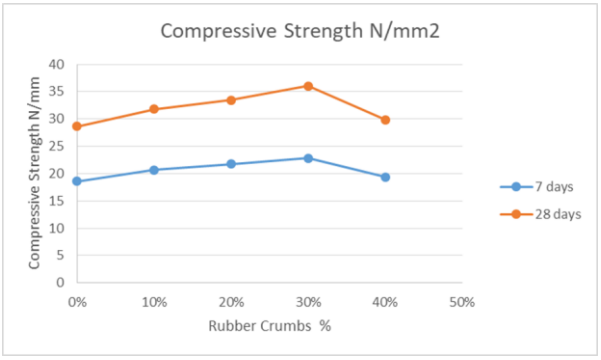



Fig 4 Compressive Strength

Above Results show that there is a marginal increase in Compressive strength in replacement of Rubber Crumbs at the 30% of at the age of 7, 28 days and gets slightly decreased at the 5-10%.

C. Split Tensile Strength

Table 4.4 Split Tensile Strength

| Rubber Crumbs % | 7 days | 28 days |
|---|---|---|
| 0% | 1.16 | 1.78 |
| 10% | 1.21 | 1.84 |
| 20% | 1.37 | 2.11 |
| 30% | 1.49 | 2.29 |
| 40% | 1.28 | 1.97 |

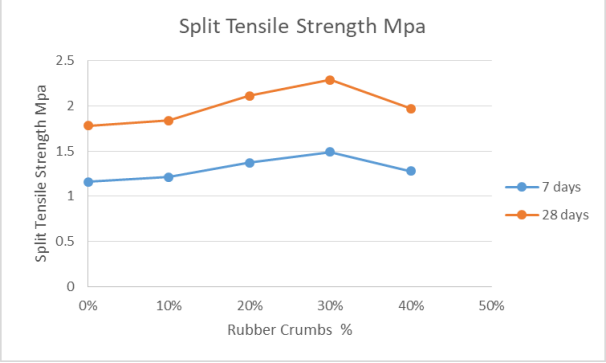



Fig 5 Split Tensile Strength

Above Results show that there is a marginal increase in Split Tensile Strength in replacement of Rubber Crumbs at the 30% of at the age of 7, 28 days and gets slightly decreased at the 10-15%.

## IV. CONCLUSION

Pervious concrete has experienced a resurgence in modern construction, addressing urbanization challenges such as stormwater runoff and waste management. Composed of large aggregates with minimal fines, it allows water to permeate, aiding in efficient stormwater management and groundwater recharge. A noteworthy feature is the incorporation of rubber crumbs, often recycled from tires, in the concrete mix. This not only contributes to waste management by repurposing recycled materials but also enhances the concrete's strength. The case study indicates that replacing up to 30% of M20 grade concrete with rubber crumbs improves structural performance. This approach offers substantial environmental benefits by reducing landfill burdens and promoting a circular economy. Pervious concrete, with its dual advantages of stormwater management and waste utilization, emerges as an innovative and sustainable solution for urban areas facing environmental challenges.

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IS Codes

- IS10262:2009, “Guidelines for Concrete Mix design”.
- IS: 4031 (Part IV)-1988 and found to be confirming to various specifications
- IS:12269-1987 - Ordinary Portland Cement, 53 Grade — Specification
- IS 383:1970 - Specification for Coarse and Fine Aggregates. From Natural Sources For Concrete
- IRC:44-2017 - Guidelines For Cement Concrete Mix Design For Pavements