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"EVALUATION AND ANALYSIS OF SELF-PURIFYING MORTAR WITH INCORPORATED CONSTRUCTION DEBRIS AND TiO_2"

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Abstract : This study aims to investigate the impact of compressive strength on concrete when using conventional and self-purifying mortar ratios. Additionally, the research will examine the compressive strength of concrete concerning the concentration of titanium dioxide additives. Furthermore, the relationship between the strength of concrete and curing time will be explored. Another objective of this study is to analyze the strength characteristics of mortar made by adding titanium dioxide and construction debris. The research will employ Scanning Electron Microscopy (SEM) to confirm the self-cleaning process of TiO2 and perform a microstructure study.

***Keywords:Debris** usage,Environmental toxic absorbant.*

1 Introduction

Concrete is everywhere, whenever human have inhabited, concrete is there. Home, institutions, hospitals, industry, and footpath all make use of concrete, it is an excellent material to make long-lasting and energy efficient building. However, even with good design, human need change and potential waste will be generated. This, result is generation of construction debris and debris waste as estimated 900 billion tonnes every year in India, Europe, US and Japan. The recycling of these waste has several advantages. In India it is estimated that about 10-12 million tonnes of waste annually are generated by construction industry These waste materials need a large place to dump and hence the disposal of waste how become a several social and environmental problem. On the other hand, beauty of natural resources like river sand in another major pollution which result in increasing the depth of river bed. The possibility of recycling demolition waste in the construction industry is thus of increasing important. In addition to the environmental benefit in reducing the demand of land for disposing the waste.The recycling of demolition waste can help to conserve natural material and to reduce the cost of waste treatment prior to disposal. A building waste recycling as aggregates is a modern approach for preventing environmental pollution through both reducing the stocks of waste and decreasing the use of natural aggregates. It has been established that materials and components recovered from demolished buildings are being reused for new construction works as well as renovation projects, especially by low-income communities in developing countries.

One of the ways to reduce these problems is to utilize recycled aggregate in the new construction concrete components. Recycling would not only conserve the resources but would also promote safe and economic use of such concrete which is the need of the hour for a country like India, Saudi Arabia etc. the waste is crushed

and sieve to obtain the size for replace the fine aggregate. concrete waste has been procured from the demolished site. The demolished waste was transported, crushed and segregated. Several tests on segregated concretes were conducted in the laboratory such as water absorption, sieve analysis, crushing value test, impact value test, and abrasion test, workability and crushing strength of natural & demolished waste by making cubes.

The demolished waste was sieved through a set of IS sieves to obtain a fineness of fine aggregate which was also replaced. Mortar is yet another building material composed of cement, which in this case is mixed with fine sands and water, with lime added to improve the durability of the product. Adding water to this mix activates the cement so that it hardens, or cures, just as with concrete. Mortar is not as strong as concrete and typically is not used as a sole building material. Rather, is it the "glue" that holds together bricks, concrete block, stone, and other masonry materials. similarly our project mainly deals with the replacement of debris with Msand in cement mortar. The good quality and required quantity of cement and fine aggregate have been used for both the nominal mixes, the replacement of construction debris in different proportions for concrete is reviewed in the reference(4) (12) .

Here replacing fresh fine aggregate by 0%, 25%, 50%, 75% and 100% demolished waste aggregate concrete for both mixes have been prepared and cubes were caste. 7 days and 28 days compressive strength of the cubes have been obtained The value of apparent density and open porosity can be obtained. The optimum percentage of replacement of fine aggregate can be identified and in addition to this the percentage of titanium dioxide by 2%,4%,6%,8% to define the optimum percentage. Then the microscopic study can be done for the optimum percentage of mortar with debris and titanium dioxide. At last, the self-purifying property of mortar can be proved by some experiments.

2.1 Materials and methods used

This chapter explains the types and properties of the materials used for the preparation of self-purifying mortar with partial replacement of debris. It also includes mix proportions and mixing. The methods are generally called as the techniques or arrangement of work for a preparation of self-purifying mortar with replacing of debris.

2.1.1 Compression strength

The compressive strength of the mortar was measured on 70.6 mm x 70.6 mm x 70.6 mm. All were cast in three layers, and each layer was fully campacted using the mortar cube vibrator. After casting, specimen were kept at room temperature for 24 h. Then they were demoulded and transferred to the curing tank where they were stored until their testing dates. The compressive strength was measured at the age of 7, and 28 days using the universal testing machine (UTM) with the capacity of 400 kN. For each mixture each specimens were tested according to a relevant IS standard. The following figure 3.7 represents the UTM machine under loading conditions

2.1.2 SEM Analysis

SEM scans a focused beam of electrons across the specimen and measuresany of several signals resulting from the electron beam interaction with the specimen. The most commonly used imaging modes are secondary electron, backscattered electron, and x ray. Images are monochrome since they reflect the ciectron or x-ray flux resulting from the beam / specimen interaction. Computer-based image processing and analysis make routine quantitative imaging possible.

2.1.3 Apparent Density and Open Porosity Determination

The hydrostatic weighing technique for apparent density and open porosity measurements was carried out by means of a balance OHAUS-PA213 provided by Pioneer. The samples were dried in an oven at 110'C for 12 h and weighed after cooling at room temperature (weight of dry sample: md). Afterwards, the specimens were placed in an empty desiccator and kept in a vacuum for 30 min.Later, the desiccator was filled with water, and the samples were kept immersed for 2 h in a vacuum and then weighed (weight of soaked sample: ms).

Finally, the samples were weighed when immersed in water at atmosphere pressure (soaked immersed sample: mi).

3 Results and Discussions

As results will elaborate more on the findings gathered of this project. This will perform all the mechanism involved with the result refers to the self-purifying cement mortar. Base on the result occurred, I would discuss about the performance of the mortar and any things that related with the project.

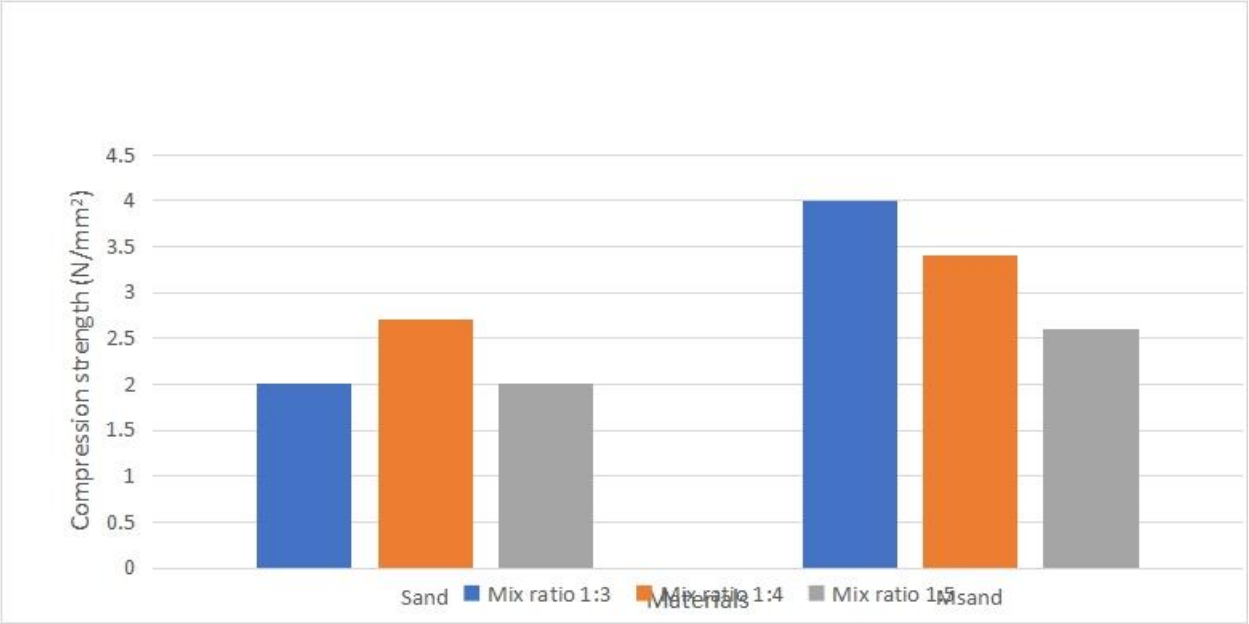
3.1 Compression test

The compression test of mortar cube could do with the help of the Universal testing machine with the capacity of 400 kN. The compressive strength of the mortar was measured on 70.6 mm x 70.6 mm x 70.6 mm. All cubes were cast in three layers, and each layer was fully compacted using the mortar cube vibrator. The test for normal mortar and self-purifying mortar could be taken for mortar cube after 7 days curing. The strength of self-purifying mortar is higher than the conventional mortar. There is a major difference in strength after 7 days curing which should be described below in a table and comparison are shown in chart.Table 4.1, indicates test for conventional mortar. The replacement of construction debris in different proportions for concrete is reviewed in the reference(4) explains the replacement of debris with 20%, 50% and 100%. And reference(13) examines the replacement of debris with ratio 100:0%, 80:20%, 50:50%, 20:80%, 0:100% for concrete. In both literatures, the compression strength is increased some percentage of replacement.

Compression test value for conventional mortar

Cement mortar	**1:3**		**1:4**		**1:5**	
	Sand	**Msand**	**Sand**	**Msand**	**Sand**	**Msand**
Strength (N/mm^2)	2	4	2.81	3.45	2	2.71

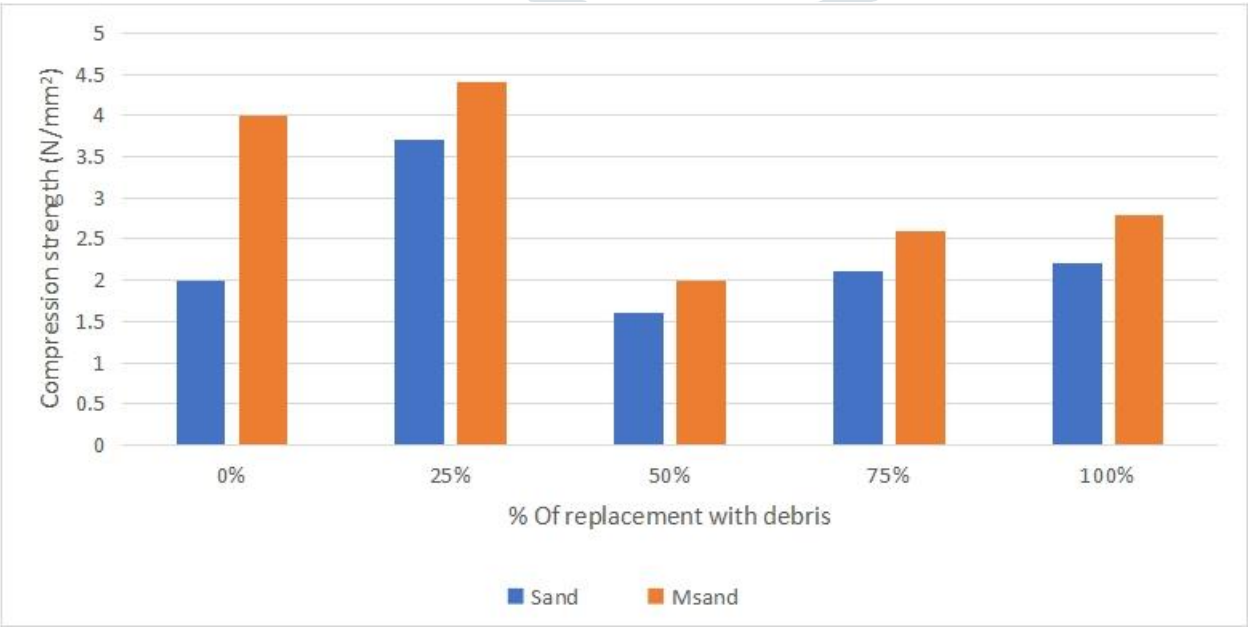
The bar graph, is the compression test value obtained fram conventional mortar with sand and Msan



Compression strength for conventional mortar

Compression test value for conventional mortar with replacement of construction debris for mix ratio 1:3

Cement mortar	**25% of debris**		**50% of debris**		**75% of debris**		**100 % of debris**	
	Sand	**Msand**	**Sand**	**Msand**	**Sand**	**Msand**	**Sand**	**Msand**
Strength (N/mm^2)	3.81	4.41	1.63	2	2.15	2.61	2.21	2.79



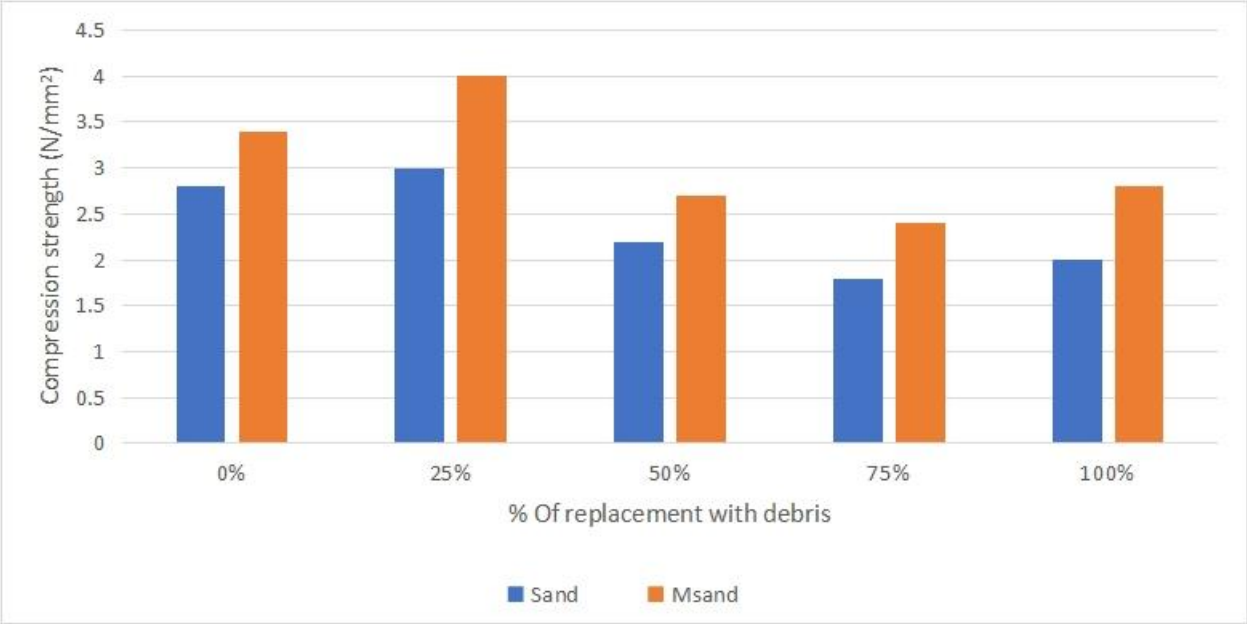
Bar graph , is the compression test value observed for conventional mortar of sand and Msand with the replacement of debris for mix ratio 1:3 respectively.

Compression strength for conventional mortar with debris for mix ratio 1:3

The table 4, test for conventional mortar, with replacement of debris for mix ratio 1:4, respectively.

Compression test value for conventional mortar with replacement of construction debris for mix ratio 1:4

Cement mortar	**25% of debris**		**50% of debris**		**75% of debris**		**100 % of debris**	
	Sand	**Msand**	**Sand**	**Msand**	**Sand**	**Msand**	**Sand**	**Msand**
Strength (N/mm^2)	3	3.98	2.21	2.81	1.87	2.41	2	2.65



The bar graph, is the compression test value observed for conventional mortar of sand and Msand with the replacement of debris for mix ratio 1:4 respectively.

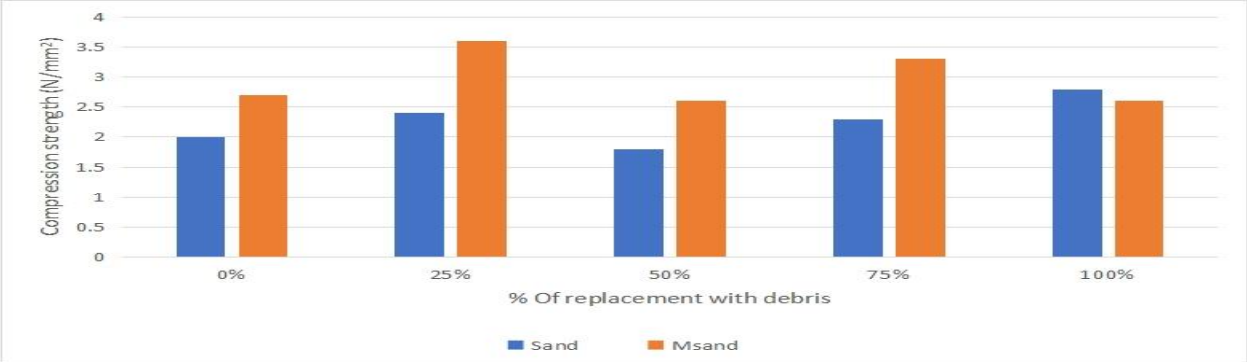
Compression strength for conventional mortar with debris for mix ratio 1:4

The test for conventional mortar, with replacement of debris for mix ratio 1:5 respectively.

Compression test value for conventional mortar with replacement of construction debris for mix ratio 1:5

Cement mortar	25% of debris		50% of debris		75% of debris		100 % of debris	
	Sand	Msand	Sand	Msand	Sand	Msand	Sand	Msand
Strength (N/mm^2)	2.41	3.57	1.81	2.67	2.27	3.23	2.81	3.51

The bar graph , is the compression test value observed for conventional mortar of sand and Msand with the replacement of debris for mix ratio 1:5 respectively.



Compression strength for conventional mortar with debris for mix ratio 1:5

Therefore, the optimum percentage of debris added in preparation of mortar is 25% with 75% of Msand identified by the compression strength of the mortar.

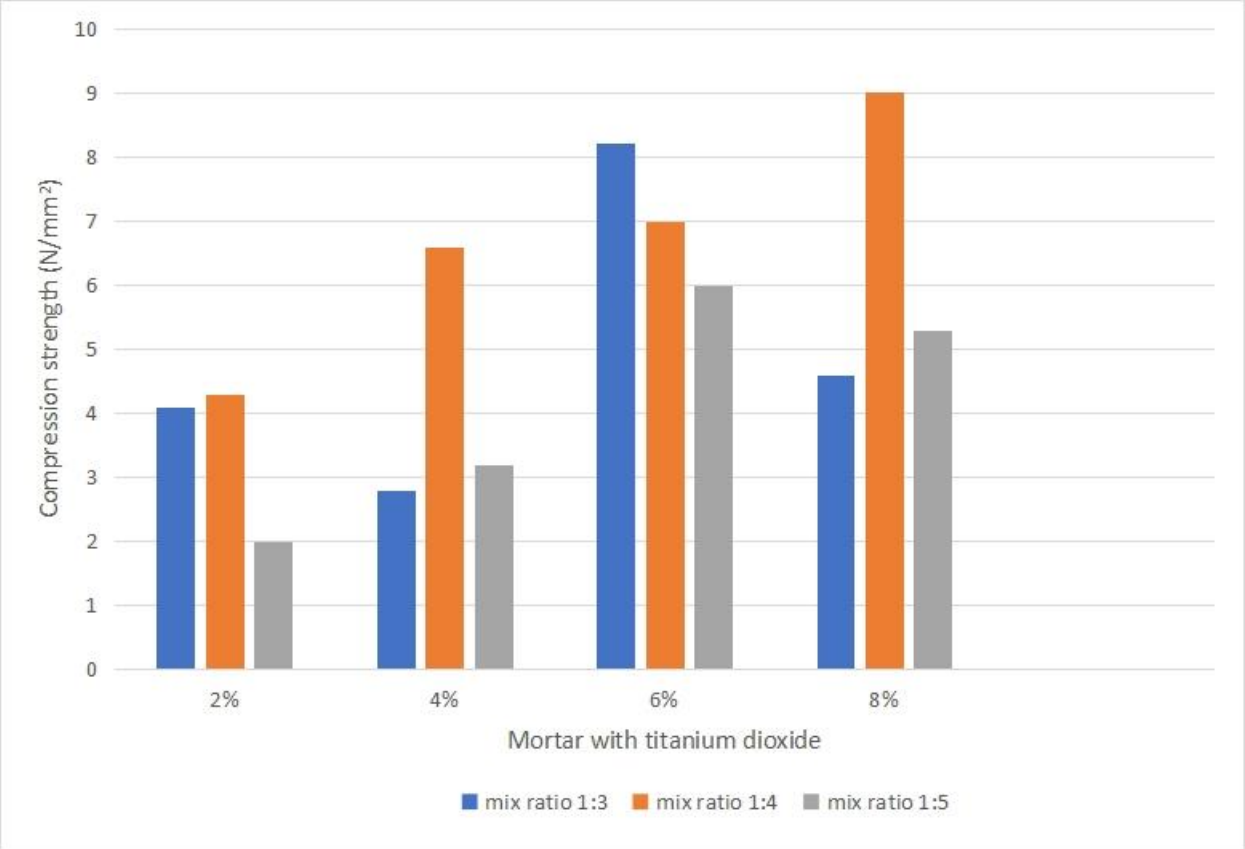
The table explains the compression test value for self-purifying mortar to find the optimum percentage for making prototype and The addition of TiO^2 in with different proportions in mortar from 1 to 5% in reference[8]. Also, the compression test for the nanoparticles added specimens are given in detail.

Compression test for self-purifying mortar

Titanium dioxide	Mix ratio	Strength (N/mm^2)	Titanium dioxide	Mix ratio	Strength (N/mm^2)
2%	1:3	4.16	6%	1:3	8.19

	1:4	4.51		1:4	7
	1:5	2.11		1:5	6.15
4%	1:3	2.81	8%	1:3	4.61
	1:4	6.67		1:4	9
	1:5	3.37		1:5	5.42

The bar graph, gives the comparison of the compression test value for self-purifying mortar with debris for easy observation.



Compression strength for self-purifying mortar

Therefore, the optimum percentage of titanium dioxide added in preparation of mortar is 8% identified by the compression strength of the mortar.

3.2 Scanning Electron Microscopy test

Scanning Electron Microscopy analysis test can be done by using an instrument called scanning electron microscope which the electrons are generated by heating by the electron gun, which acts like a cathode. These electrons are propelled towards the anode, in the same direction as the sample, due to strong electric field. After the beam of electrons are condensed, it enters the objective lens which is calibrated by the user to a fixed position on the sample.

3.3 Open porosity and apparent density test

The apparent density and open porosity test were reviewed in the reference. The open porosity of self-purifying mortar is 0.2 lower than the conventional mortar. Dust and other particles can easily penetrate through the pores of the conventional mortar but in self purifying mortar due to titanium dioxide the macro and micro pores are filled which leads to resist the penetration of dust particles into the mortar. The apparent density value of self-purifying mortar is 2 times higher than the conventional mortar. Due to increase in density, the quantity of the material decreases with same amount of volume.

3.4 Self-purifying ability

The self-cleaning ability for Tio2, added geopolymer was proved (15). Here the addition of TiO2 nanoparticles in the mortar with debris results in functional composites which have a self-cleaning ability. It is well known that TiO2 nanoparticles are an excellent photocatalyst material when it sizes below 100 mm. the self-cleaning ability of the composite made of cement, Msand, and debris were examined. The sample was found that the surface of the composite remains clean, no dirt and it can improve the life and protect the environment. The figure 4.12 shows the difference of conventions and self-purifying mortar.

4 Conclusion

The varied mortars with Nano- Tio2, photocatalysts in bulk were prepared and their plastic and hardened performances were studied. The incorporation of the Nano-additives showed a tendency to increase the water demand of the mortars, which was especially true for the addition of TiO2. This fact, which was further confirmed by particle size measurements, was due to its high specific surface area and its tendency to agglomerate, thus reducing the fluidity of the plastic paste.

The optimum percentage of replacement of fine aggregate with debris is 25% which could be observed by the compression strength after 7 days curing. The compressive strength test was taken for conventional mortar, conventional mortar with replacement of debris in different proportions and self-purifying mortar. The obtained test values were compared between conventional mortar and self-purifying mortar. The results show the compressive strength after 7 days curing of self-purifying mortar are twicer than the conventional mortar.The optimum percentage of titanium dioxide in debris added mortar is 8% which could be observed by the compression strength after 7 days curing. It acts as a photocatalyst. Presence of titanium dioxide in self purifying mortar the setting time would decreases compared to conventional mortar. The bonding between the atoms are made more stronger in conventional mortar. An additive TiO2 generates free radicals which

destroy the cell walls of bacteria, algae and reduces the permeability of structure would immensely improves its life.The morphology of the conventional and self-purifying mortar was found out by SEM. It shows the direct involvement of titanium dioxide reaction in self purifying mortar. We can see rod shaped impressions which is consistent with the rigid dimensions of the titanium dioxide on self-purifying mortar cube.

The open porosity of self-purifying mortar is lower than the conventional mortar. The apparent density value of self-purifying mortar is higher than the conventional mortar. This leads to increases self-purification capacity, strength and voids are reduced in self purifying mortar

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