International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Comparing Special Concrete and Conventional Concrete in Bridges and Precast Structures

Priyanka Sinha[1], Apeksha Chaudhari[2]

[1]M. Tech Student, Department of Civil Engineering, G. H. Raisoni University, Maharashtra, India

[2]Assistant Professor, Department of Civil Engineering, G. H. Raisoni University, Maharashtra, India

Abstract: ***India is rapidly developing, especially in transportation. Bridges and other elevated structures are crucial for smooth traffic flow. However, these structures face heavy loads throughout their lifespan, requiring high - quality concrete with strong compressive strength and durability. Traditional concrete often falls short in meeting these requirements. To enhance concrete properties for bridge construction, special ingredients like Micro silica, Poly - propylene fiber, and Bacillus Subtilis are added. This review focuses on these ingredients, their effects on concrete, and their role in strengthening its engineering properties. It discusses how these additives improve strength, durability, and overall quality of the structures.***

Keywords: Concrete, Cracks, Self - healing, Bacillus subtilis, Micro silica, Special Concrete, Poly - propylene fiber, Strength

1. Introduction

Cracks in concrete are common and allow moisture to seep in, leading to corrosion of the reinforcement and weakening of structures like bridges. To address this, high - performance special concrete is used, which combines traditional concrete with special additives. These additives, when mixed in the right amounts with regular ingredients, provide added strength, durability, and stability to the concrete. This paper investigates the effects of these additives and assesses their suitability for use in bridges and other large structures. It reviews each additive separately and examines how they improve the properties of concrete.

2. Mechanism of Special Ingredients Concrete

special ingredients concrete is a high - quality blend of materials carefully chosen to enhance the strength and durability of heavy structures like bridges. It's mixed with regular concrete to improve its overall quality. This type of concrete is specifically designed for bridges and precast components to ensure smooth operation and longevity. One special feature is its ability to self - heal: when cracks form, the concrete fills them naturally with calcite in the presence of moisture. Additionally, micro silica is added to boost compressive strength and reduce water permeability, while polypropylene fiber integrates the concrete better, enhances flexural strength, and decreases microcracks.

3. Review of Literature

3.1Blended Polypropylene Fiber for Fiber - reinforced concrete (FRC)

Divya Dharan and Aswathy Lal (2016) used a special type of Polypropylene fiber mixed into concrete at varying amounts from 0.5% to 2.0%. They conducted tests on compressive strength and flexural strength, comparing the results with regular concrete samples. They found that adding 1.5% of this blended Polypropylene fiber increased concrete's compressive strength by 17% compared to regular concrete. Additionally, flexural strength was boosted by 24% compared to regular concrete. Their study concluded that adding 1.5% of this blended Polypropylene fiber yielded the best results for enhancing concrete's strength.

3.2 Use of Micro silica in concrete

Akshay kumar Hirapara and colleagues (2016) used micro silica in concrete at different amounts ranging from 3% to 15% by weight of cement. They aimed to find the best proportion of micro silica to maximize both compressive strength and workability of the concrete. They casted various concrete cubes with different micro silica proportions and tested them after 28 days of curing. They conducted compressive strength tests and slump tests for workability. Their findings revealed that using 11% micro silica by weight of cement resulted in the highest compressive strength. Compared to ordinary concrete of the same grade, this concrete showed a 25% increase in compressive strength. Additionally, the normal consistency of the concrete increased by about 40% when micro silica was added from 0% to 15%.

Bacteria based self - healing concrete

Kusuma K. and colleagues (2018) discussed a method for self - healing concrete using Bacillus megaterium, a type of bacteria. In their study, they added a bacterial solution containing 10^5 cells of Bacillus megaterium per milliliter of water to the concrete. These bacteria break down urea in the concrete, leading to the formation of calcite. The bacteria produce urease, which converts urea into ammonia and carbonate. Ultimately, this process results in the formation of calcium carbonate, which helps repair cracks in the concrete. Various tests, including compressive strength, water absorption, and water permeability, were conducted on the concrete samples. The results showed an 11% increase in compressive strength and a significant reduction in the penetration length of water permeability.

3.3 Use of Micro silica to improve compressive and flexural strength of concrete

Amar Shitole and colleagues (2014) explored the use of silica fumes as a partial replacement for cement in concrete. They tested different mixtures of M20 grade concrete with a water - cement ratio of 0.5, substituting cement with silica fumes at levels ranging from 0% to 10%. After curing the concrete for 28 days, they conducted tests for compressive strength. The results indicated that a partial replacement of 7.5% of cement with silica fumes led to higher strength compared to regular concrete.

3.4 Influence of Polypropylene fiber on strength of concrete

Salahaldein Alsadey and colleagues (2016) aimed to determine the best amount of polypropylene fiber to achieve the highest compressive strength in M25 grade concrete. Through their experiments, they found that increasing the amount of polypropylene fiber significantly boosts compressive strength. They added polypropylene fiber in amounts ranging from 0% to 2% and casted different cube specimens for each proportion. After curing for 28 days, they tested the cubes. The results showed that the maximum compressive strength was achieved at 2% polypropylene fiber content. However, they also observed that adding fiber reduced the slump of the concrete, making it harder to handle.

3.5 Self - healing of Concrete by adding Bacillus Subtilis

Pradeep Kumar A and his team (2015) studied how adding Bacillus subtilis to concrete can help it heal itself. They designed M20 grade concrete by adding 30ml of Bacillus subtilis solution to increase its strength. The bacteria were grown on agar slants using a mixture of peptone, NaCl, and yeast extracts as nutrients. They casted four cube specimens with varying amounts of Bacillus subtilis solution (0ml, 10ml, 20ml, and 30ml) and tested them for compressive strength. The results showed that the compressive strength of the M20 grade concrete with 30ml of bacterial solution was even higher than that of M25 grade concrete, reaching 33.32 MPa. Additionally, they observed self - healing on the surface of concrete cubes, where initial cracks were repaired by the formation of a calcite layer.

3.6 Ultra High Performance Concrete for Bridges

S. Karuppasamy and colleagues (2019) introduced ultra - high performance concrete specially designed for bridges, ensuring exceptional strength, durability, and stability. This concrete is made using locally available materials like silica fumes and steel fibers, combined with superplasticizers to enhance its properties. They conducted mix design experiments, using 10% micro silica and varying amounts of steel fibers (4% and 8% by volume, and 2.5%, 5%, 7.5%, and 10% by weight of cement). Afterward, they performed compressive strength and tensile strength tests on concrete cubes. The results revealed that a combination of 7.5% steel fiber and 10% micro silica achieved the highest compressive and tensile strength after testing for 7 and 28 days.

3.8 Effects of Addition of Micro Silica on properties of High strength Concrete

Sabale V. D and colleagues (2014) studied the use of micro silica in different amounts for designing M60 grade concrete while keeping the water - cement ratio at 0.3. They used silica fumes in proportions ranging from 0% to 15% of the weight of cement. Then, they tested the compressive strength, splitting tensile strength, and flexural strength of each sample after 7 and 28 days. They found that replacing cement with micro silica up to 10% increased all three strengths, but beyond that, the strengths decreased. As micro silica increased, the workability of the concrete decreased, requiring more water. Overall, using silica fumes improved the performance of the concrete significantly compared to normal concrete.

3.9 Investigation on Properties of High Strength Bacterial Concrete

Neha Singla and her team (2016) investigated an environmentally friendly method for self - healing concrete using Bacillus subtilis bacteria. They conducted experiments by cultivating the bacteria using two different mediums: Nutrients - broth and Urea. Cube specimens were then made by adding Bacillus subtilis solution at varying concentrations: None, 10^4, 10^5, 10^6, and 10^7. They tested the compressive strength and split tensile strength of the specimens after 7 and 28 days. Additionally, they analyzed the samples using SEM (Scanning Electron Microscopy) and observed the formation of a calcite layer in the bacterial concrete. They found that in the urea medium, the compressive strength increased by 27%.

4. Advantages and Disadvantages of Special Ingredients Concrete

4.1 Advantages

1) Increases compressive strength and flexural strength of concrete.
2) Reduces porosity and permeability of concrete, making it less prone to water penetration compared to regular concrete.
3) Enhances durability and serviceability of structures by minimizing steel corrosion.
4) Lowers maintenance costs of structures made with special ingredient concrete compared to ordinary concrete.
5) Self - healing properties of this concrete reduce maintenance costs even further.
6) Polypropylene fiber presence reduces microcracks and strengthens the structure.

4.2 Disadvantages

1) This concrete costs a lot more at the start than regular concrete.
2) Getting the special ingredients can be hard to do in certain places.
3) You need to be really skilled and know a lot to grow the bacteria for self - healing concrete.
4) Checking how the calcite layers form is really tough and can cost a lot of money.

5. Application of Special Ingredients Concrete

a) Bridges and Elevated Viaducts.
b) Pre - stressed concrete girders.
c) Flyovers and Precast segments.
d) Underground and elevated Metro structure.
e) Box culverts, Water retaining structures.

6. Conclusions

1) The review found that adding special ingredients to regular concrete makes it much stronger.
2) The study also found that Bacillus subtilis and other similar bacteria types can repair cracks in concrete by forming a layer of calcite when there's moisture.
3) Micro silica, when used in the right amount, around 10% of the cement's weight, effectively boosts concrete's compressive strength.
4) Using blended Polypropylene fiber at a rate of 1.5% to 2% also strengthens concrete, improving both flexural and compressive strength.
5) Concrete with special ingredients is more durable and reliable, reducing the risk of reinforcement corrosion.
6) When these ingredients are mixed just right, they enhance concrete quality, making it stronger and longer - lasting while also reducing water permeability.
7) Special ingredient concrete performs exceptionally well in heavy structures like bridges and tall roads.
8) In conclusion, special ingredient concrete excels in meeting all the requirements for smooth functioning of bridge structures.

References

[1] International Journal of Science Engineering and Research (IJSER) Volume 4, Issue 8, 2013 ISSN 2229 - 5518.
[2] Ajay Verma, Chandak Rajeev, and R. K. Yadav "Effect of micro silica on the strength of concrete with ordinary Portland cement. " Research Journal of Engineering Sciences (RJES) ISSN 2278 (2012): 9472.
[3] Akshaykumar hirapara, Brijesh ramani, Kaushal kathiriya, Jatinkumar patel; "Use of Micro silica in concrete" International Research Journal of Engineering and Technology (IJIRST) Volume 2 | Issue 11 |.
[4] Alavi Nia. A., M. Hedayatian., and M. Nili., "An experimental and numerical study on how steel and polypropylene fibers affect the impact resistance in fiber - reinforced concrete", International Journal of Impact Engineering, January 2012, pp.62 - 73.
[5] Amarkhail, N. (2015), "Effect of micro silica fume on high strength concrete", International Journal of Technical Research and Applications, 13 - 19.
[6] Amsa M, Ariyannan P; "Experimental study on polypropylene fiber reinforced concrete" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 04, Apr - 2018.
[7] Amudhavalli, N. K. & Mathew, J. (2012). "Effect of silica fume on strength and durability parameters of concrete", International Journal of Engineering Sciences & Emerging Technologies, 28 - 35
[8] Ajay Verma, Chandak Rajeev, and R. K. Yadav. "Effect of micro silica on the strength of concrete with ordinary Portland cement. " Research Journal of Engineering Sciences, ISSN 2278 (2012): 9472.
[9] Aditya Dhagat, Manav Mittal; "Effect of Microsilica and fly ash on the strength of concrete" (IJSER) Volume 4, Issue 8, 2013 ISSN 2229 - 5518.
[10] S. S. Patil, A. A. Patil, Properties of polypropylene fiber reinforced concrete, (IJCET), Vol.05, No.04 (Aug 2015).
[11] Zhang. p, Li. Q. F, Effect of Polypropylene fiber on durability of concrete containing fly ash and silica fumes, International journal of engineering and science, Vol.1, PP 01 - 04, (2012).
[12] S. Sunil Pratap Reddy, M. V. Seshagiri Rao, Performance of ordinary grade bacterial concrete (Bacillus subtilis), (IJESE), ISSN 0974 - 5904, Vol.03. (2016).