



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS**

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Thesis Title: STUDIES ON THE INFLUENCE OF ADMIXTURES ON THE PERMEATION AND MECHANICAL CHARACTERISTICS OF FOAM CONCRETE FOR USE IN LIGHT-WEIGHT INTERLOCKING BLOCKS

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SHORT ABSTRACT

Foam concrete (FC), generally classified as a cellular light-weight concrete with density ranging from 400 kg/m³ – 1850 kg/m³, is produced by the introduction of stable air voids into the cement paste (or mortar). Based on the existing literature, it is evident that besides the conventional filling and thermal insulation applications, FC also has potential for specialized applications such as stabilization of weak soils, seismic isolation medium for underground reactor containments and tunnel linings and subbase layer in case of road pavements. Further, highly permeable material such as FC, has the potential to stabilize unstable slopes, through its application in landfills, horizontal/ vertical drains and retaining walls and providing reliable drainage path in order to dissipate pore water pressure and make slopes drier and stronger. However, the literature review concludes that the quantum of research reported in aforementioned areas is very limited.

Conventional FC is typically proportioned to achieve only low compressive strength (e.g., between 1 and 10 N/mm²), suitable for its use in void fill and trench reinstatement, and thus the material is largely disregarded for use in structural section. Adding to above, it is surprising to note that very few researchers have used class F FA as potential alternative for sand in FC. Moreover, use of PP fiber in FC showed enhancement in the tensile strength, water absorption capacity and permeability. From the limited literature available on the use of FA, PP fiber and their combination, it is evident that their combined use, helps in the enhancement of mechanical properties and permeation characteristics of FC.

Particularly for concrete structures such as retaining walls, dams, reservoirs, and marine structures, interaction with water is more common rather than gas/ air/ water vapour, hence it is more rational to measure the permeability of FC using the water permeability method. Here it is to be noted that, the existing sample sealing mechanism to measure water permeability of porous concrete such as FC, have limitations such as ingress of molten sealant into sample

and applicability to only low-pressure head (3 kg/cm^2). Hence, a novel sealing mechanism using the rubber membrane and iron clamp setup has been developed in the present study to measure the water permeability of FC for higher pressure of up to 7 kg/cm^2 .

Another important fact is manual error, construction cost, time and resource consumption can be reduced through the incorporation of interlocking concept in masonry. Hence, it is evident that, the interlocking block (IB) concept along with highly permeable materials such as FC, can facilitate construction of dry cast segmental retaining walls even in remotely placed locations.

The present study is restricted to FC and foam concrete interlocking block (FCIB) made of preformed foaming method with the identified mix components viz. ordinary Portland cement (OPC) 43 grade, sand ($< 300 \mu\text{m}$), FA (up to 100% as sand replacement), PP fiber (up to 1%), superplasticizer (PCE based), sodium lauryl sulphate (SLS) (surfactant) and carboxymethyl cellulose (CMC) (additive). A constant cement sand ratio of 1:2 is adopted throughout the study. The first phase of studies comprises of studies on the relative fresh state, hardened state and permeability properties of FC (with design density of 1000 kg/m^3 (FC1), 1500 kg/m^3 (FC2) and 1800 kg/m^3 (FC3) produced using FA (50% as sand replacement) and PP fiber (0.05%) along with variation in foam content. Here it is to be noted that, for use in retaining wall applications, minimum strength of at least 20.7 N/mm^2 is needed as per ASTM C1372-23 guidelines. Further, addition of foam and PP fiber enhance the permeability of FC while decreasing its spreadability and mechanical properties. Based on the preliminary investigations it was found out that the FC2 (density = 1500 kg/m^3), is exhibiting a maximum compressive strength of 14.2 N/mm^2 along with a satisfactory permeability of 10^{-3} cm/s .

Having identified the potential mix composition of FC which could result in desired strength as well as permeability for its intended application, further studies are attempted to improve the strength and permeability of FC2 through variation in FA level and fiber content. The matrix modification of FC2 using both FA and PP fiber have shown a significant increase in compressive strength of FC2 up to 462% and 358% with a maximum of 25 N/mm^2 and 29 N/mm^2 compressive strength for the SFC2F4P2 mix at the age of 28 days and 56 days respectively. Further, the split tensile strength of these combination mixes is exhibiting significant enhancements of up to 573% and 512% at the age of 28 days and 56 days respectively due to combined effect of FA and PP fiber. Based on the experimental outcomes, the SFC2F1P2, SFC2F2P2, SFC2F3P2 and SFC2F4P2 mixes have been selected as most suitable mixes (based on cube strength results) for the intended application in accordance with ASTM C1372-23.

Further, studies on properties of FCIB (blocks and triplets) produced with satisfactory mixes (i.e., SFC2F1P2, SFC2F2P2, SFC2F3P2 and SFC2F4P2) have been conducted in terms of compressive strength, shear resistance and permeation characteristics. Due to the variation in IB pattern, shape and size, the compressive strength of FCIB is found to be 57% to 74% of FC cubes of size 50 mm which is in line with the literature reported by Jaafar et al., 2006. However, out of all the mixes, only the SFC2F4P2 mix (at 56 days of curing) meets the minimum compressive strength requirement of 20.7 N/mm^2 as recommended by ASTM C1372-23, for its intended use as dry-cast segmental retaining wall units.

As a next step, the mechanical properties i.e. compressive strength and shear resistance of the masonry triplets prepared using the proposed FCIB is examined. It is discovered that the compressive strength of FCIB triplets ranges from 30% to 51% of FCIB, which is in line with research results reported by Jaafar et al., 2006. Further, these FCIB triplets have a shear resistance that ranges from 18% to 36% of their compressive strength when loading is in a direction perpendicular to the header or stretcher face. Additionally, due to the improved ductility behaviour derived from PP fiber, both FCIB and triplets (under compressive or shear forces) exhibit a prolonged load bearing capacity.

Furthermore, the water absorption by these FCIB's is in the range of 10% to 17% at various testing ages, which is within the limits recommended by ASTM C1372-23. On the other hand, these FC2 mixes are exhibiting a water permeability in the order of 10^{-5} cm/s which is higher than that of the conventional concrete. Hence, the proposed FCIB produced with SFC2F4P2 mix consisting of cement: FA= 1:2 and PP fiber content of 0.4% at W/S of 0.3 and SP dosage of 1.1% (at 56 days of curing) has the potential to be used in dry cast segmental retaining walls to facilitate dissipation of pore water pressure behind retaining walls. However, further studies are needed to verify the pore water pressure dissipation effect when used in retaining walls.

