INSWAREB
Visakhapatnam

PRESS NOTE

Irrational Concrete with Rational Performance?

All maladies of durability of concrete, by and large, emerge out of one development, the transition zone ie., the 'zone of bond' between cementitious matrix and stone (coarse aggregate). If one can avoid coarse aggregate in concrete, without sacrificing the performance requirements, concrete attains new definition, devoid of transition zone, and many durability issues would be addressed in one stroke. No-Aggregate concrete (NAC) has emerged out of this durability-agenda, aiming simultaneously the agenda for Sustainable Development.

In construction parlance mortar is the combination of cement, sand (fine aggregate), and Concrete is the combination of cement, sand, stone (coarse aggregate), water being the common input in both the cases. Concrete is used as structural media, mostly in association with reinforcement which is called RCC (Reinforced Cement Concrete).

If one develops a cementitious mixture for RCC and such mixture does not contain stone, do we call it as concrete? In engineering parlance, it is irrational to call a cementitious product as concrete when it is devoid of aggregate. It is also irrational to have the concrete of low density with high order of strength development (40-80 MPa). But the researchers rationally call it as concrete because of its amenability to serve the applicational needs and performance criteria of a concrete with better engineering properties. The researchers claim that the No-Aggregate Concrete (NAC) would prove more durable than conventional concrete, almost by 10-20 times. This is the fete achieved out of the research of Dr. Bhanumathidas and Kalidas at INSWAREB labs, Visakhapatnam.

The insight into durability of concrete brings up various issues of physical and chemical relevance. All maladies of durability, by and large, emerge out of one development, the transition zone ie., the 'zone of bond' between cementitious matrix and stone (coarse aggregate), leading to hostile issues such as:

- accumulation of free lime;
- formation of lengthy and low density crystals of lime developing weak link and flexure-failure;
- development of micro cracks due to tensile shrinkage owning to differential density of stone to matrix; and
- ultimate vulnerability to chemical attacks, more so due to presence of free-lime.

If one can avoid coarse aggregate in concrete, without sacrificing the performance requirements, concrete attains new definition, devoid of transition zone, and many durability issues would be addressed in one stroke. NAC emerged out of this durability-agenda, aiming simultaneously the agenda for Sustainable Development.

One should know that, when cast into a prism by adding water and made into stiff paste, cement alone, without containing any aggregate, does develop a compressive strength of 60 to 80 MPa. But, fine and coarse aggregate are added to cement with the following primary objectives:

- to render workability, facilitating placement and application.

- to avoid shrinkage in cement paste and attaining volume stability to concrete.
- to contain heat of hydration of cement, for avoiding thermal cracks in concrete.
- to moderate/regulate the strengths (10 to 40 MPa) conducive to structural needs.
- to rationalize the cost of concrete by adding aggregate of lower costs than cost-intensive cement.

A mix has been developed at INSWAREB labs, which serves all the above applicational issues and thus the researchers claim it as the concrete, owing to its performance characteristics, though it does not contain coarse aggregate. This unique research aims at articulating the performance of fly ash as pozzolanic binder on one hand and micro aggregate on the other, nullifying the role of coarse aggregate.

RCC beams: with OPC concrete (left) and NA-concrete (right)

What are the other features of this No-Aggregate Concrete (NAC)!

1. Moderate water is required for curing, as the cast product is porous-free and internal (mix) water would accomplish considerable curing needs.

2. The matrix of NA-Concrete is as dense as ceramic with negligible porosity. Thus the durability is expected to be over 1000^{+} years.

3. The strength of NA-Concrete ranges at 40-80 MPa, by two to four fold of conventional concrete. Thus the structural sections could be considerably rationalized saving material and money.

4. By no presence of coarse aggregate, NAC emerges devoid of transition zone nullifying the negative features of performance.

5. The specimen studied through accelerated curing proved the bond strength (concrete to steel) at par to that of high performance-OPC concrete. Long term studies are in progress.

6. The density of this concrete is around 1800 kg/cu.m as against 2400 kg for conventional concrete. Thus there could be considerable savings in structural design

and inputs. This differential density would open up new vistas in designing of structures resistant to earthquake impact.

The NA-concrete cube after distress of bond strength

Which are the applicational avenues that would be benefited?

a. NAC is ideal for cast in-situ applications with need of neither vibrators nor compactors.

b. Lack of aggregate eliminates segregation ensuring homogeneity of the mass and matrix.

c. NAC is easily pumpable for executing cast in-situ walls and slabs, achieving compaction and leveling without additional efforts.

d. Due to high strength performance by walls cast out of NAC, columns may be eliminated as specific entity through due structural design, transferring the load of structure to the walls. This results in immense material savings and speedy construction.

e. Wall thicknesses could be rationalized increasing the floor area.

Cast in-situ wall with NAC : De-shuttered partially

What are the constraints of this concrete?

As chemical admixture is unavoidable, the concrete preparation and placement has to be undertaken under specialist's supervision.

What are the benefits of this concrete?

The use of coarse aggregate would be totally avoided, conserving the natural stone, hillocks and hills. The use of sand as fine aggregate is optional, to conserve the river beds.

This is a typical Project serving the agenda of Sustainable Development, and its qualification as CDM Project is yet to be established.

Conclusions:

NAC would open up new vistas and challenges in the construction industry.

A lot of scope of research lies for structural engineers to understand the behaviour of NAC and define applicational methodologies through innovative structural designs.

This is the concrete for future generations who may get stuck for want of coarse aggregate due to depletion of natural resources by the earlier generations.

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