Abstract:

Ultra-high performance concrete (UHPC) is being seen as the most innovative and impactful development in the field of construction materials. It uses a relatively high amount of binder, usually has a water to cementitious ratio of less than 0.2, shows a compressive strength in excess of 150 MPa (22 ksi), and is characterized by superior durability properties compared to conventional concrete. The addition of tailored discontinuous fibers leads to significantly higher ductility and durability of the cracked matrix. Its key property is a dense and low permeable concrete matrix [1]. This provides excellent resistance against chlorides, sulfates, and other aggressors. Use of UHPC reduces the cross section of structural members as we can get the higher mechanical properties with smaller cross section than using conventional concrete. It can be used for the quicker construction by utilizing the concept of accelerated bridge construction (ABC), yet can provide increased load resistance, enhanced durability and ductility. The UHPC has been extensively used in the European countries, yet it is not widespread in the rest of the world.

Current drawbacks in the wide-spread use of UHPC are the high material cost and the proprietary nature of commercially available products [2].

Typical Ingredients:

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| --- | --- | --- |
| Ingredients | Constituents | Size |
| Cement | Moderate Fineness, Low C3A, High C3S + C2S | 10-20µm |
| Silica Fume | Low Carbon Content | 0.2-1µm |
| Silica Powder |  Silicon Dioxide (SiO2) | Median size (1.7µm) |
| Silica Sand | Higher quality w/ high strength & low water absorption |  |
| Superplasticizer | High Range Water Reducer |  |

Use of white cement, silica powder, and finely refined silica sand produces highly expensive UHPC. In this research, we use following approaches to make UHPC economical, yet providing similar mechanical and durability properties:

1. Use of locally available materials i.e. transportation of material from one part of the world to another costs a lot.
2. Replacing the finely refined silica sand with locally available aggregates
3. Removing silica powder from the matrix
4. Replacing the portion of silica fume by cement
5. Use of type II/V cement instead of white cement

References:

1. Wille, K., Naaman, A.E, Parra-Montesinos, G. J, “Ultra-High Performance Concrete with Compressive Strength Exceeding 150 Mpa (22 Ksi): A Simpler Way”, ACI Materials Journal, Vol. 108-1, 2011.
2. Wille, K., Boisvert-Cotulio, C. “Material Efficiency in the Design of Ultra-High Performance Concrete”, Elsevier – Construction and Building Material, Vol. 86, 2015, pp. 33 – 43.