NEW CONCRETE

Concrete, an important construction material used all over the world, is conventionally made from Portland *cement, coarse aggregate, fine aggregate and water* and has compressive strength varying from 100 to 300 kg/cm^2. As for brittle materials in general, *concrete is strong under compression and weak under tension or flexure*.

Concrete is normally believed to be durable, serviceable and practically maintenance free with good long term performance, but in large number of cases the concrete has failed to perform as expected and premature deterioration at much earlier ages has been noticed. Most of them start suffering from corrosion of reinforcement due to durability distress ranging from unsightly staining to spalling of the concrete. The reasons are mostly

- Improper choice of materials
- Poor design and detailing
- Poor construction practices
- Poor mix design
- Ignorance of the environmental effects

An attempt is made here to introduce new concepts in the formation of concrete, which has been possible due to continued research and the recent developments in material and construction technologies.

- **Self Compacting Concrete (High Performance Concrete)** means the concrete, in which vibration is not required as the concrete flows like water and it has very high viscosity. Such type of concrete can be made by using specific kind of super-plasticiser and powder, which makes the concrete to act like water. The strength of such type of concrete is not governed by the w/c ratio; in fact the strength of concrete is completely dependent on water powder ratio. At the first time it was used in Japan in 1988.

  The SCC known as high performance concrete may be used successfully in case of multi-storied buildings due to its characteristics: *Strength*, *Durability* and *Workability*.

  On the basis of manufacturing cost, SCC is about 20% costlier than the conventional concrete of similar compressive strength which is compensated by several benefits of using it such as saving in electricity, saving in labor cost related to compaction work, increase in productivity etc.

  Now-a-days, its use is very common in advanced countries, where labour cost is very high. The advantage of this concrete is to avoid the Honey Combing and segregation.

  In Railways, its intensive use can be made in the confined zone where vibrating compaction is difficult like lining of tunnels, PSC girders including anchorage blocks and multi-storied frame structures, water tanks etc.

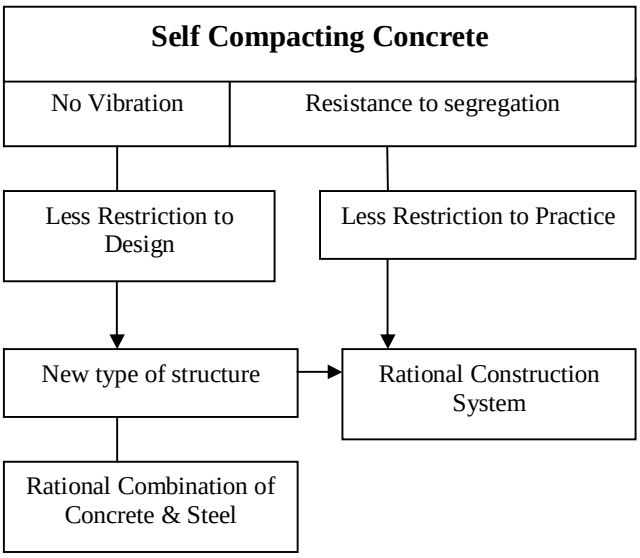




Fig: Anchorage of Akashi-Kaikyo Bridge

- **Polymer Concrete Composites** are made from polymers added to concrete to improve its compressive strength, fatigue resistance, impact resistance, toughness and durability. These are highly impermeable and *resistant to attack by acids, alkalies and other chemicals*. They can be classified as :

  - **Polymer Concrete (PC)**: Polymer/Monomer (acting as binder in place of cement) and the aggregate (necessary to pre-heat the coarse and the fine aggregate while mixing monomer) are mixed together and the monomer is polymerised after placement of concrete in position. PC serves as a very good dielectric (insulating) material. It can be used with advantage *to prevent deterioration and spalling of concrete and corrosion of reinforcing steel*.

  - **Polymer Modified Concrete (PMC)**: A monomer or polymer is added to a fresh ordinary concrete mix in a liquid, powder or dispersed phase and subsequently allowed to cure to get the resultant concrete, which improves workability, strength, adhesion, chemical resistance, impact resistance, abrasion resistance besides having increased impermeability and reduced absorption. The Polymer-cement ratio is generally 6-20% by weight. PMCs can be used with advantage *in*

overlays to bridge decks, deep patching, parking garages, industrial floors etc.

Note: *Now-a-days, it is hardly used because of a bad balance between its performance and cost in its applications.*

- **Polymer Impregnated Concrete (PIC)**: Ordinary hydrated Portland cement concrete is impregnated with a low viscosity monomer (vinyl chloride, styrene, chloro-styrene etc.) and is subsequently polymerised in-situ by radiation or by heat treatment to convert the monomer filled in the voids into solid plastic. The most widely used monomer is *Methyl Methacrylate*, which offers superior rates of impregnation and polymerisation. *Vinyl Ester Gel* (water-soluble acrylic monomer) is used for injection and sealing of joints and cracks against water leaks. PIC products on account of their high resistance to wear and tear, impact etc. are used *as kerb stones, pre-cast slabs for bridge decks, repairing of leaking floors, etc*.

- **Relative Properties of PC Composites compared to Normal Concrete**

Property	PIC	PMC	PC	PCC
Compressive Strength	3-5	1-2	1.5-10	1
Tensile Strength	4-5	2-3	3-6	1
Elastic modulus	1.5-2	0.5-0.7	0.05-2	1
Water absorption	0.05-0.1	-	0.05-0.1	1
Freeze-thaw resistance no. of cycles/% wt. loss	2000-4000/0-2	-	1500/0-1	700/25
Acid resistance	5-10	1-6	8-10	1
Abrasion resistance	2-5	10	5-10	1

PCC – Plain Cement Concrete

Note: *Although, Portland Cement Mortar and Concrete are continued to be used as repair materials either in their original form or as injection grouts, with or without the use of admixtures and chemicals. The new repair materials such as polymer concrete composites are being increasingly employed in repair and rehabilitation jobs owing to their very high strength and durability characteristics.*

- **Super-plasticised Concrete** is formed by incorporating highly effective super-plasticisers as admixtures to improve durability, to increase the workability of concrete, to permit use of less quantity of water; thereby producing high-strength concrete without increasing cement. In general, super-plasticiser can be added in concrete in doses upto 0.7% by weight of cement. These may be very useful for repairing isolated slabs.

  There may be three possible situations, in which super-plasticised concrete may be adopted:

  - When it is required to produce concrete of required strength with *reduced quantity of cement*.
  - When it is required to produce high-strength concrete having *a very low water cement ratio*.
  - When it is required to produce concrete having *good flowability without any danger of bleeding, segregation or reduction in strength*.

  Presently available super-plasticisers are ***Sulphonated Napthalene Formaldehyde Condensate, Sulphonated Melamine Formaldehyde Condensate, Modified Ligno Sulphonates, Hydroxy alkyl Sulpho-nates and Other Organic Materials***. *Generally the manufacturers keep it secret. Therefore, these behave differently with different cement.*

  SNF and **SMF** type super-plasticisers have been used widely for strong and durable concrete and allow water reduction to the tune of 20-30% without affecting the workability.

  Note: *The requirements for all types of Super-plasticisers are as listed **(a)** No additional air entrainment than the standard level **(b)** No set Retardation unless otherwise specified **(c)** No detrimental side effects **(d)** No detrimental effect on over dosing **(e)** Compatibility with all cements used for construction activity **(f)** Should not show any tendency of bleed and segregation in concrete **(g)** No negative effect on hardened concrete.*

- **Fibre Reinforced Concrete** is formed by adding fibres (either steel or glass of asbestos) of small diameter, short length and randomly distributed in the mixture to improve the tensile strength and impact resistance of concrete. Following two types besides others are mostly recommended:

  - When 2 to 3% of *Steel fibres* (by volume) added, the flexural strength of concrete may be increased two to three times resulting in substantial increase in explosion resistance, crack resistance and other properties of the concrete. Steel Fibre Reinforced Concrete is considered suitable for the construction of pavements, bridge decks, industrial floorings, pressure vessels, tunnels lining etc.
  - When 10% of *glass fibres* (by volume) added, the tensile strength of concrete may be increased almost two times resulting in substantial increase in impact resistance of concrete. The strength of glass fibre increases as its diameter is reduced. They are very brittle and get corroded due to the effect of alkalies present in Portland cement. To utilise glass fibres as micro reinforcement, they are suitably treated (coating with epoxy resin compounds etc.) to protect them from alkali attack. Investigations are on to use glass fibre reinforced concrete in the manufacture of precast products like spun pipes, wall cladding etc.

- **Sulphur Impregnated Concrete,** is formed by adding molten sulphur to the pre-heated aggregate in a mixer (no cement and water is required). The hot mix is then poured in mould to form pre-cast unit that

develops high compressive strength at an early age. The main advantage of this type of concrete is that it can be re-used and re-moulded without any wastage and is more *durable in acidic environments* but is unstable in alkaline conditions. This type of concrete is not suitable for structural work due to its brittleness and corrosive action of sulphur on reinforcement but may be used in industrial plant and for tunnels lining.

- **Ultra High Strength Concrete,** in which it is possible to get concrete having compressive strength exceeding 1000 kg/cm^2 by adopting suitable method of production. It can be produced by :

  - *Improved compaction and adhesion of cement matrix to aggregates or by adoption of cementatious aggregates.*

  - *Use of high quality course aggregates, synthetic aluminious fine aggregates and cement.*

  Use of high temperature to increase the lime silica bond and use of spiral wrapping of concrete to induce triaxial stress are the other techniques being tried to develop ultra high strength concrete.

  By use of ultra high strength concrete, load bearing capacity of columns can be increased considerably and it is possible to adopt slender columns in multi storied buildings which besides looking aesthetically good also permits greater utilisation of useful floor space. On account of its high compressive as well as tensile strength, this type of concrete finds wide application in pre-stressed concrete.

- **Roller-compacted Concrete,** in which the dry concrete material is consolidated by external vibrations using vibratory rollers. It differs from normal concrete basically in its consistency. This type of concrete is used with *advantage in mass concrete work* and laid in thin layers of about 25 cms. in depth in continuous operation. This type of concrete permits *faster construction & saving in labour cost*.

- **Applications:** In Railways, their use may be specific to the requirement such as

  - in industrial floors (*acidic environment*);
  - in repairing of floors and other structural members of concrete;
  - in sealing of joints and cracks against water leaks;
  - in the foundations where water table is high;
  - in deterioration and spalling of concrete and corrosion of reinforcing steel;
  - in pre-stressed concrete;
  - in construction of pavements, bridge decks, tunnel linings, wall cladding, deep patching, parking garages, etc.

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NEW CONCRETE

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*A*dvanced
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Maharajpur, Gwalior - 474 005 (INDIA)

✆ : 0751 - 2470869 & Fax : 0751 - 2470841

Our Objective

To upgrade Maintenance Technologies and Methodologies and achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability, and Utilisation.

The contents of this pamphlet are informative and ***not statutory****. For more in-depth information and details, the reference may be made to the relevant codes and reports available on the subject.*

If you have any suggestion & comments on contents of the pamphlet, please write to:

Director (Civil), CAMTECH, Maharajpur, Gwalior (M.P) – 474 005