Flow of Presentation

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Self compacting concrete (SCC) [1]

- SCC was developed first in Japan in the late 1986s by Prof. Okka Mura at Ouchi University and in 1989s prototype was developed Prof. Ozwal at University of Tokyo.

- **Self-compacting concrete is considered a concrete that can be placed and compacted under its own weight without any vibration effort, assuring complete filling of formworks even when access is hindered by narrow gaps between reinforcement bars**.

- The composition of SCC are fly ash, glass filler, limestone powder, silica fume etc. with some super plasticizer is mixed.

https://www.google.co.in/search?q=congested+reinforcement&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwi-lO7uwKDSAhXKOI8KHV0fB6oQsAQIIQ#imgrc=DBCt1k1NNTDYuM:

Why self compacting concrete required?

- The problem of the durability of concrete structures has been a major problem.
- Over vibration can easily cause segregation.
- Requirement of skilled worker for compaction in conventional concrete that is eliminated in SCC.
- Difficulties to use mechanical compaction for fresh concrete.
  - ✓ Underwater concreting
  - ✓ Cast in-situ pile foundation
  - ✓ Columns with congested reinforcement

Material of SCC [3]

- **Cement :**
  - Ordinary Portland Cement 43 or 53 grades [EN 197-1]
- **Fine Aggregates :**
  - Particles bigger than 125 micron and smaller than 4.75 mm.
- **Course Aggregates :**
  - The maximum size of aggregate is generally limited to 20 mm
  - Aggregate of size 10 - 20 mm is desirable for structures having congested reinforcement.
- **Water :**
  - Ordinary portable water of normally pH 7 is used for mixing and curing the concrete specimen.
- **Admixtures :**
  - Mineral Admixtures
  - Chemical Admixtures

Material of SCC [2]

- **Mineral Admixtures**

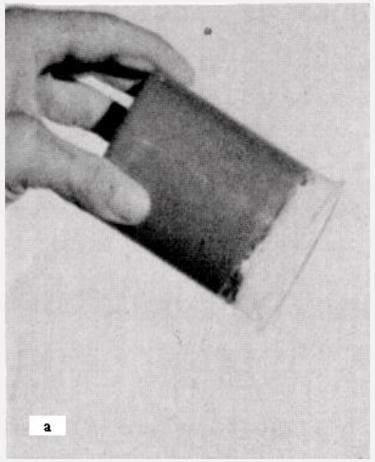
Pozzolanic + $Ca(OH)_2$ + Water = C - S – H (Gel)

- Fly Ash:- Improve the quality and durability of SCC
- Ground Granulated Blast Furnace Slag (GGBS):-
  - by-product from the blast-furnaces used to make iron.
  - Cementatious and pozzolanic material.
  - improve rheological properties.
- Silica Fume:- Improve mechanical properties of SCC.
- Stone Powder:- Crushed lime stone, dolomite or granite may be added to increase the powder content.
- Fibres:- Fibres may be used to enhance the properties of scc in same way as for normal concrete.
  i.e. Steel Fiber, Polymer Fiber.

Material of SCC [4]

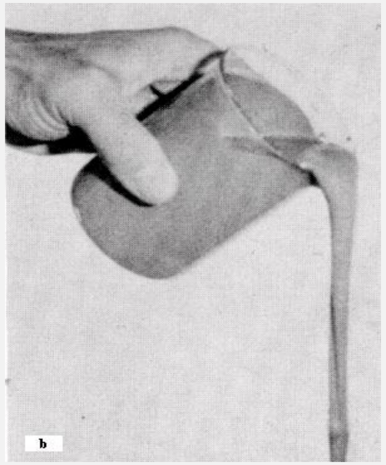
- **Chemical Admixtures:-**

- **Super plasticizer**:-
  - Super plasticizer (high-range water-reducers) are low molecular-weight, water-soluble polymers designed to achieve high amounts of water reduction (12-30%) in concrete mixtures in order to attain a desired slump.
  - Super plasticizer based on Naphthalene or Melamine are generally not suitable for SCC required very high strength.



Cement and water

Cement, water, and super plasticizer

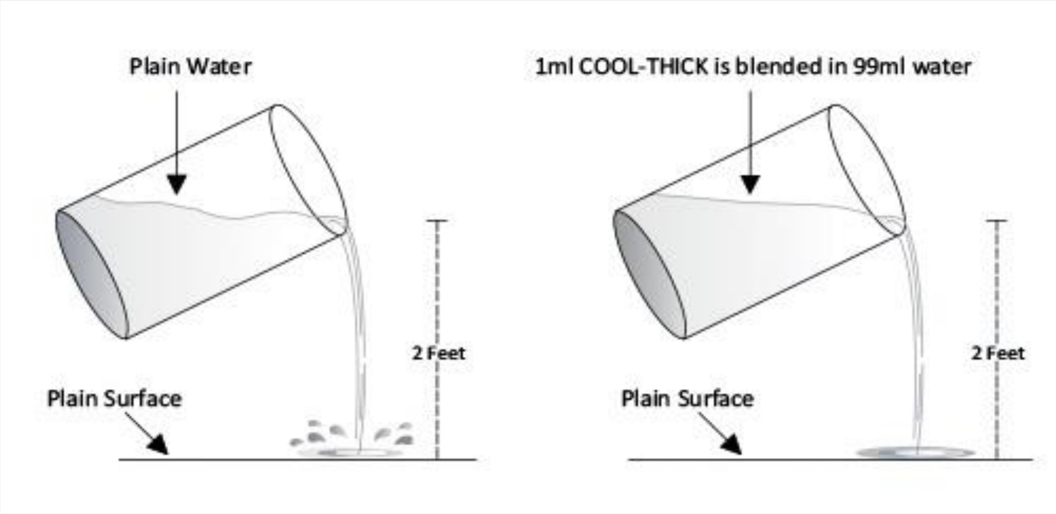


Material of SCC [5]

➢ **Chemical Admixtures:-**

➢ **Viscosity Modifying Agent :-**

- Viscosity modifiers are high molecular-weight, water-soluble polymers used to raise the viscosity of water. And reducing its tendency to segregate and bleed.

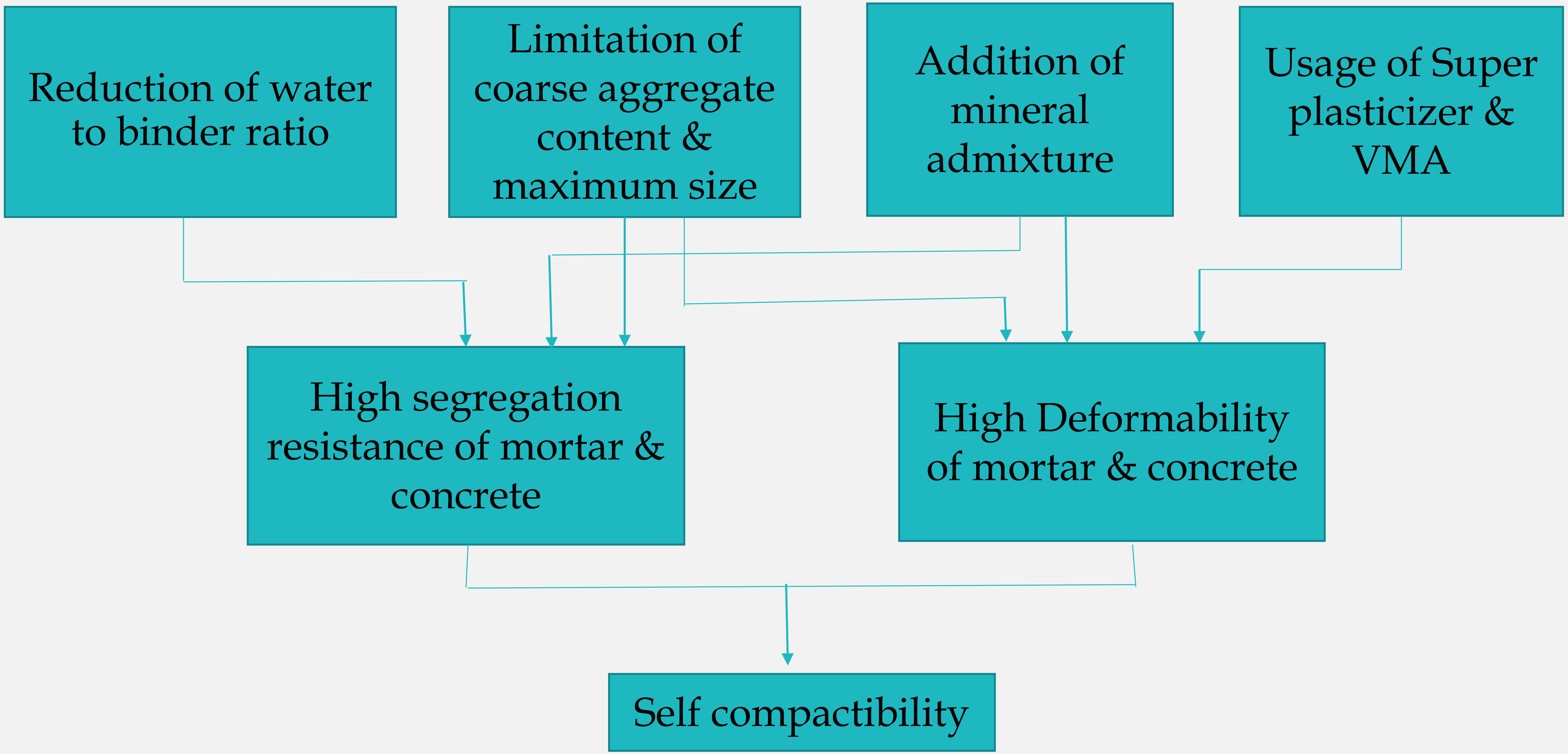


(a) Plain water (b) 99% Water + 1% VMA

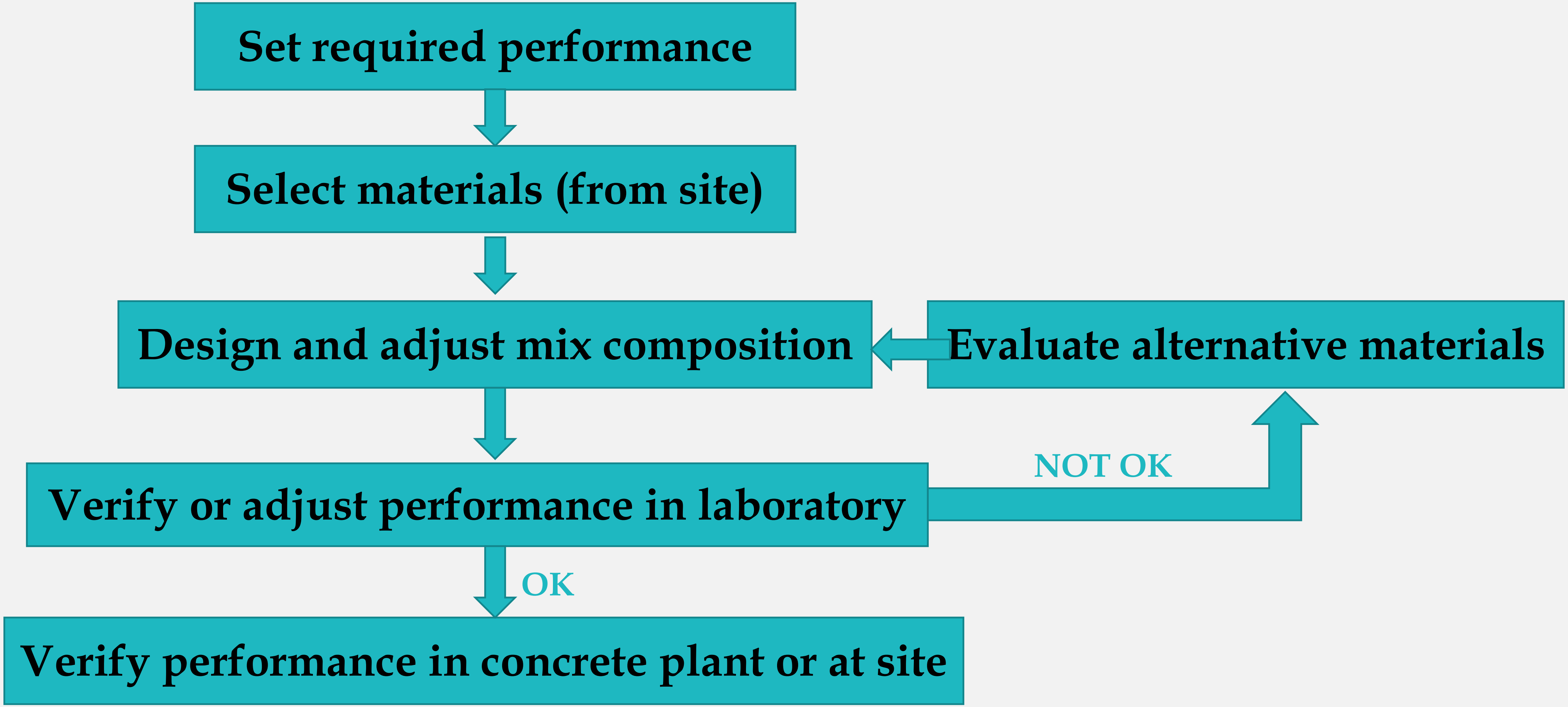
➢ **Air Entraining Admixtures (AEA) :-**

- Air entraining admixtures used for removal of air voids in mixtures.

Flow Chart for achieving self compatibility



Mix Design Procedure



Mix Design & Initial Mix composition [3]

➢ **Mix composition:-**

Water/powder ratio	=	0.8 to 1.0
Total Powder content	=	400-600 kg/m^3 (160 to 240 liters)
Sand Content	≤	40% of the mortar (by volume)
Sand	≤	50% of past volume
Sand	≥	50% by weight of total aggregate
Coarse aggregate	=	28% to 35% by volume of mix
Free water	<	200 liter
Paste	>	40% of the volume of the mix
Super plasticizer	=	2% to 3% by weight of the binder content
Viscosity Modifying Agent	=	0.2% to 0.5% by weight of the binder content

Characteristics of SCC

- **SCC mixes must meet three key properties:**
  1. Ability to flow into and completely fill intricate and complex forms under its own weight.
  2. Ability to pass through and bond to congested reinforcement under its own weight.
  3. High resistance to aggregate segregation.
- A concrete mix can only be classified as SCC if it has the following characteristics:-

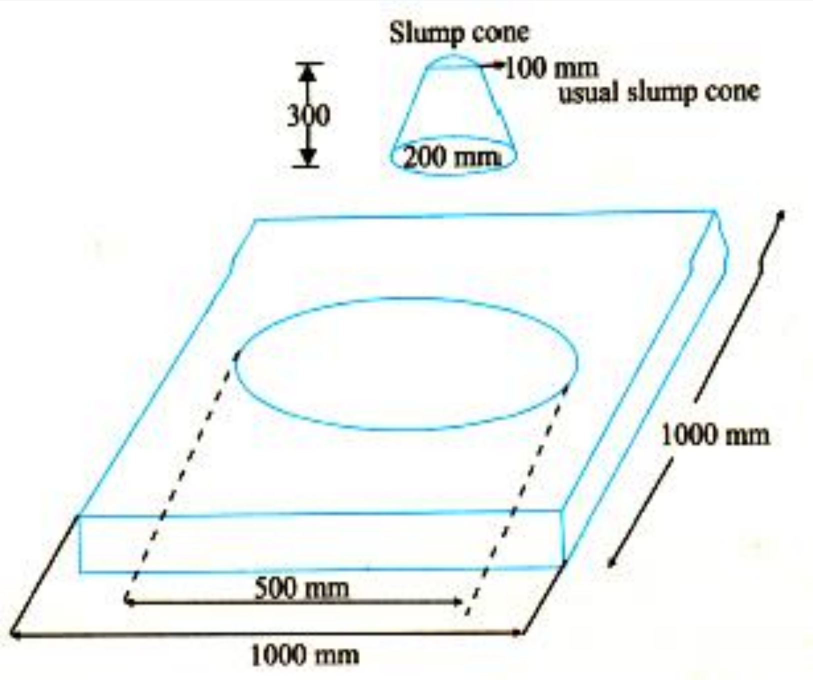
1. Filling Ability
   - ✓ Slump flow test, T50 cm slump flow , V-Funnel test

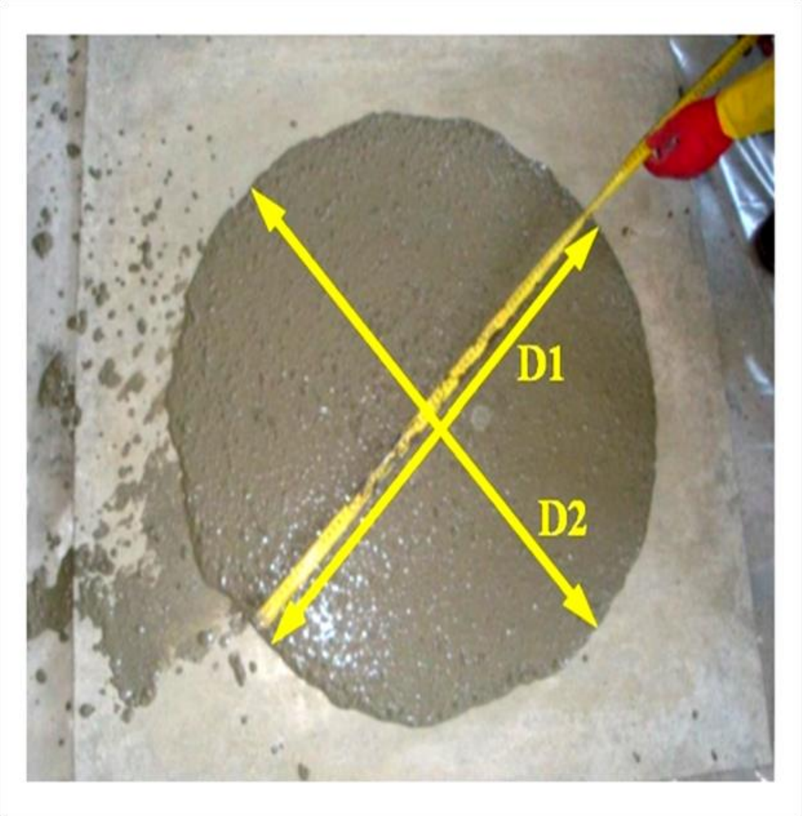
2. Passing ability
   - ✓ J-ring test, U-box, L-box

3. Segregation potential
   - ✓ V-Funnel T5 minute Test

Workability Property Test

✓ **Slump Flow Test & T_{50} cm Slump Flow:-**





Criteria for
- Slump Flow- 650-800mm
- T50 cm Slump Flow- 2-5 sec

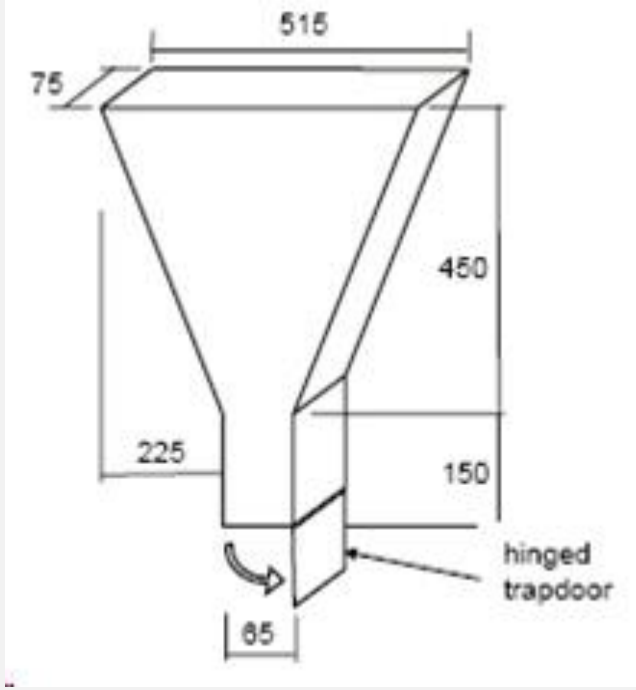
Workability Property Test

✓ **J-ring Test :-**

Criteria for
J-ring Test- 0-10 mm

Workability Property Test

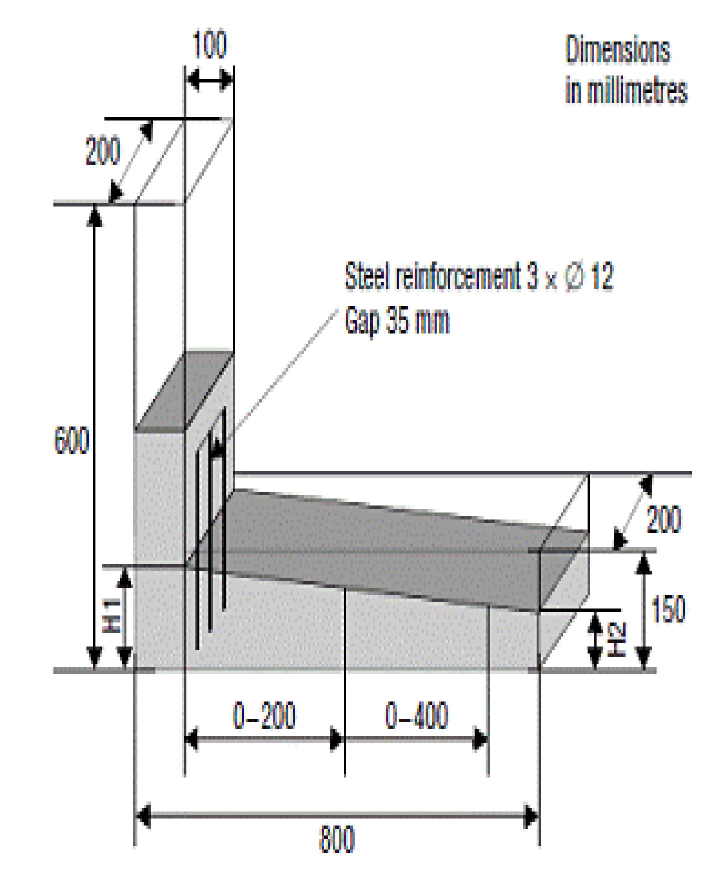
✓ **V-funnel and V-funnel at T5 minutes:-**



Criteria for
V-funnel- 8 - 12 sec
V-funnel at T5 minutes- +3 sec

Workability Property Test

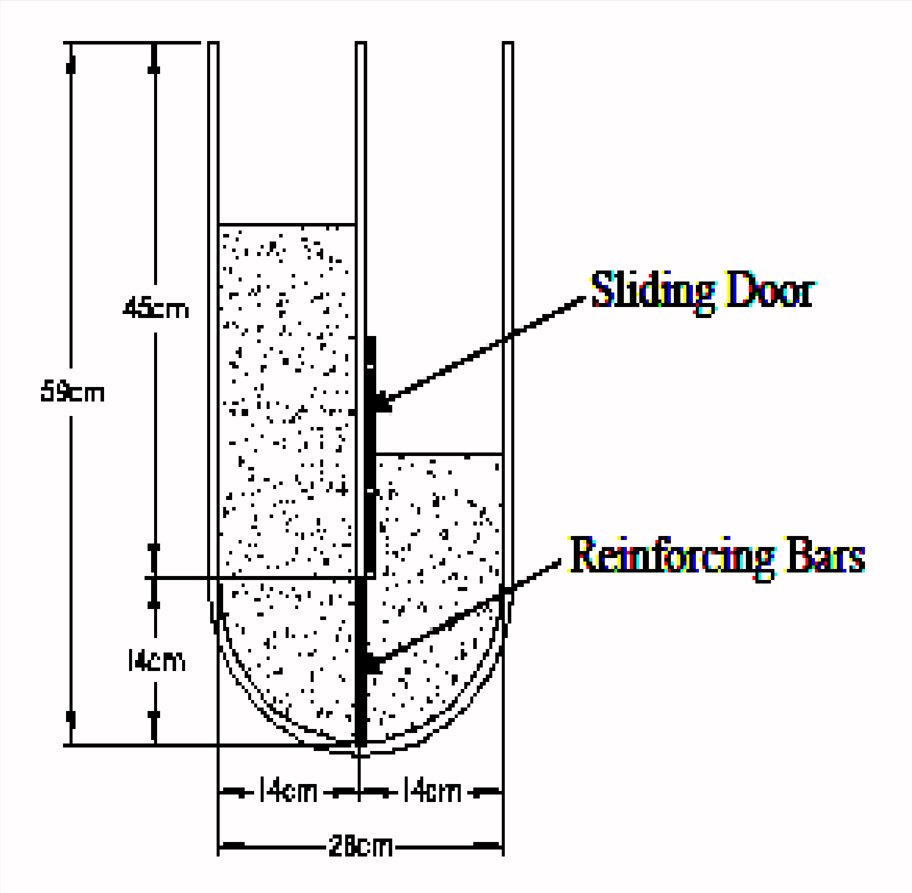
✓ **L–Box Test :**



Criteria for
Blocking ratio H2/H1- 0.8-1.0

Workability Property Test

- ✓ **U Box Test :**



Criteria for
Filling height H1-H2- 0-30 mm

Workability Requirement for the fresh SCC [3]

Sr No.	Methods	Unit	Typical ranges of values	
			Minimum	Maximum
1	Slump flow	mm	650	800
2	T_{50}cm Slump Flow	sec	2	5
3	J- ring	mm	0	10
4	V- funnel	sec	8	12
5	V- funnel at T_5 minutes	sec	0	+3
6	L-Box	(h2/h1)	0.8	1.0
7	U- Box	(H1-h2) mm	0	30

Case Study-1: Delhi Metro Project [2]

- Mix Proportion adopted at Delhi Metro Project For 35 Mpa SCC

Materials	Mix Design
Water (kg)	163
Cement (kg)	330
20mm (kg)	455
10mm (kg)	309
Sand (kg)	917
Fly Ash (kg)	150
Glenium 51 (liter)	2.4
Glenium stream 2 (liter)	0.96
Possolith 300 P (liter)	0.66

Materials	Mix Design
Fresh density (kg/m^3)	2340
Quantity of fines	525 kg
Water/Powder ratio	0.85%
Paste Content by vol.	36%
Sand Content by vol.	35%
Coarse Agg. By vol.	28%

Case Study-1: Delhi Metro Project [2]

- Trial Result at Delhi Metro Project

Method	Property	Unit	Min.	Max.	Trial Result
Slump flow	Filling ability	mm	650	800	680
V-Funnel	Filling ability	Sec.	8	12	8
L-Box	Passing ability	mm	8	1.0	0.91
U-box	Passing ability	%	0	30	15
V-funnel at 5 min.	Segregation	Sec.	0	+3	+2

- The strength of SCC poured at Delhi Metro, on the basis of cube strength was between 44 and 49 Mpa at 28 days.

How Economical Is SCC? [2]

		Control Concrete		SCC	
	Rate Rs	**Quantity kg**	**Amount Rs**	**Quantity kg**	**Amount Rs**
Cement	3000/ton	450	1350	400	1200
Fly ash	1500/ton	-	-	175	263
Natural sand	900/tom	627	564	225	203
Crushed sand	850/ton	267	227	680	578
Course Aggregate					
20 mm	370/ton	510	189	405	150
10 mm	370/ton	430	159	330	122
Water	-	-	-	-	-
PCE–based admixture	140/l	-	-	5.175	725
Super plasticizer	33/l	11.25	371	-	-
Retarder	50/l	1.35	68	0.575	86
VMA	40/l	-	-	0.575	23
Total			2928		3350

Benefits & Limitations of SCC

- **Benefits of SCC**
  - Faster construction,
  - Reduced noise level, due to absence of vibration
  - Safer working environment,
  - Reduction in site manpower,
  - Easier placing,
  - Uniform and complete consolidation
  - Better surface finishes,
  - Improved durability,
  - Increased bond strength,

Benefits & Limitations of SCC

- **Limitations of SCC**
  - Its supply cost is two to three times higher than that of normal concrete.
  - The major difficulty in SCC should be fully flow-able but Without bleeding or segregation.
  - An uncontrolled variation of even 1% moisture content in the fine aggregate will have a much bigger impact on the theology of SCC at very low w/c ratio.
  - The mix design method and procedures are too complicated for practical implementation.

Concluding Remarks

- We can reduce the in-place cost and maker a safer working environment for the workers.
- SCC can be effectively placed in most congested areas and also where normal methods of vibration are not possible.
- Further research are required to interpret influence on the hardened properties of SCC more precisely.
- The cost of SCC is 10 – 15 % higher than the conventional concrete.

References

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Thank you