SELF COMPACTING CONCRETE (SCC)

CONTENTS

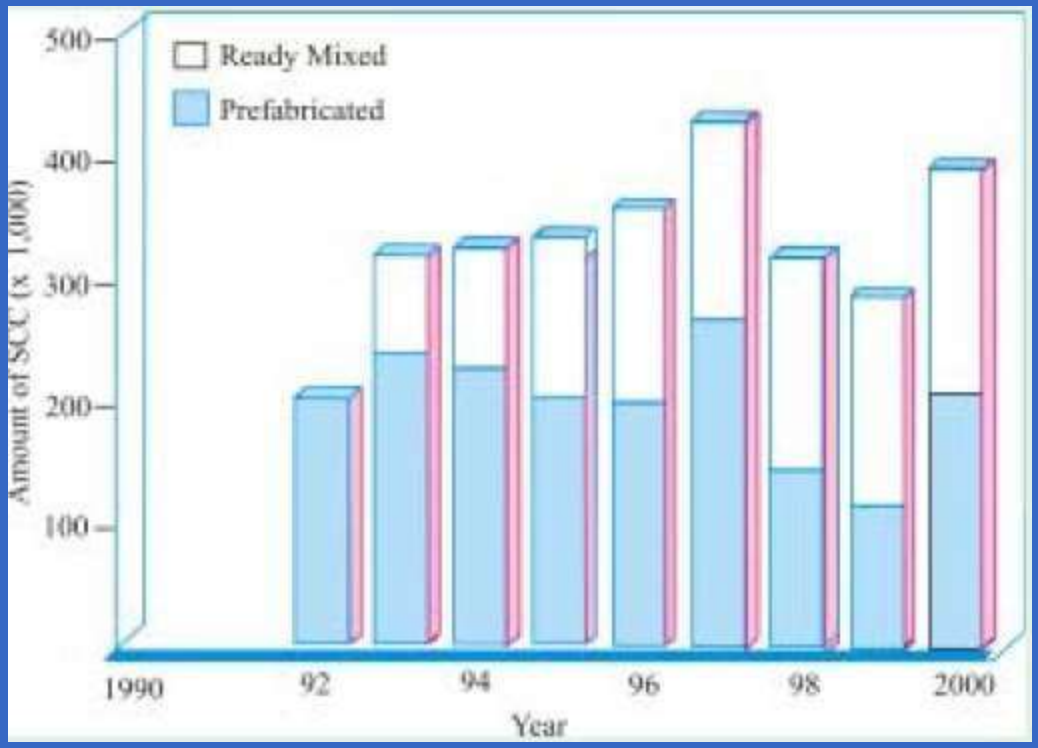
INTRODUCTION

- Self compacting concrete is an innovative concrete that does not require vibration for placing and compaction.
- Self compacting concrete is a concrete that can be compacted into every corner of a formwork purely by means of it's own weight , with out using any external vibrators.
- It is a highly engineered concrete with much higher fluidity.

DEVELOPMENT OF SCC

- In 1983,there occurred a great problem while studying the durability of concrete structures in japan.
- The problem is that to made a durable concrete an adequate compaction is necessary by skilled labour.
- So as a solution for the above problem “scc” was created by okamura in 1986.
- Hence okamura is known as the father of “scc” technology.

- At first scc is only used in pre-fabricated products and ready mixed concrete in japan.



- Self compacting concrete has been described as "the most revolutionary development in concrete construction foe several decades".

MATERIALS REQUIRED

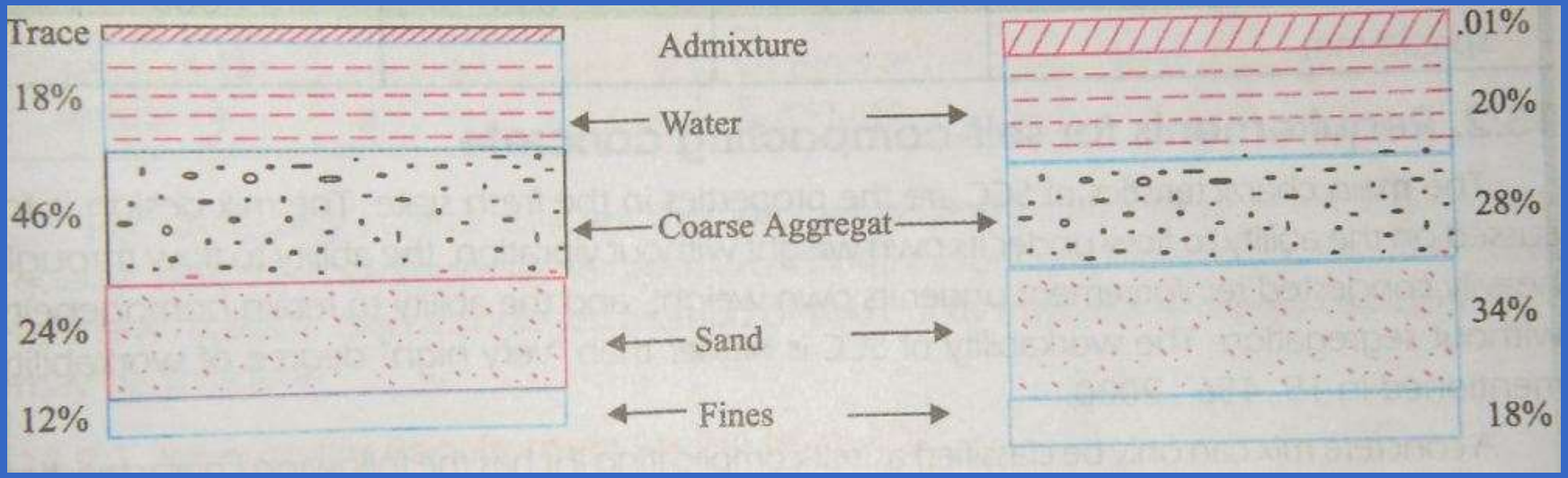
- Cement
- Fine aggregates
- Coarse aggregates
- Water
- Chemical admixtures such as super plasticizers , Viscosity modifying agents(VMA),Air entraining agents(AEA)
- Mineral admixtures such as fly ash , GGBFS , silica fume.

- Cement : Ordinary portland cement of 43 or 53 grade can be used.
- Aggregates : well graded cubical or rounded aggregates are desirable.
- Water quality : maintained same as reinforced concrete.
- Chemical Admixtures : Super plasticizers particularly poly-carboxylated ethers are used in scc. VMA and AEA are also used.
- Mineral Admixtures :
  - Fly ash : it improves the quality and durability of concrete.
  - GGBFS : It improves rheological properties(semi-solid & liquid state)
  - Silica Fume : it improves mechanical properties.
- Stone powder : finely crushed limestone,dolomite,granite may be added to increase powder content.

COMPARISION OF MATERIALS USED IN NORMAL CONCRETE AND SCC

NORMAL CONCRETE

SCC



PROPERTIES OF SCC

In fresh state , scc have the following properties

- Filling ability : flows easily at certain speed into formwork
- Passing ability : Passes through reinforcement without blocking
- Seggregation resistance : the distribution of aggregate particles remains homogeneous in both vertical and horizontal direction

PRODUCTION AND PLACING

- Proportions of materials are taken based on volume rather than by mass
- Aggregates : should come from same source
- Mixing : it should be done for longer time when compared to conventional concrete
- Placing : some rules need to be followed while placing the concrete:
  - Limit of vertical fall distance to 5 meters
  - Each layer should be at a height of 500 mm
  - Horizontal flow should not exceed 10 meters
- Curing : early curing is necessary for scc

MIX DESIGN *principles*

- The flow ability and viscosity of paste can be controlled by proper proportioning of water/power ratio and then adding super-plasticizers and VMA.
- The paste is the vehicle for the transport of the aggregate, therefore the volume of the paste must be greater than the void volume in the aggregate.
- In order to control the temperature rise and thermal shrinkage cracking as well as strength, the fine powder should be added to keep the cement content at an acceptable level .e.g.., fly ash, mineral filler, silica fume, GGBFS (Ground-granulated blast-furnace slag)

MIX DESIGN

The following sequence is followed:

- Determine the desired air content
- Determine the coarse aggregate volume
- Determine the sand content
- Design the paste composition
- Determine the optimum volumetric water/powder ratio and super-plasticizer dosage in mortar

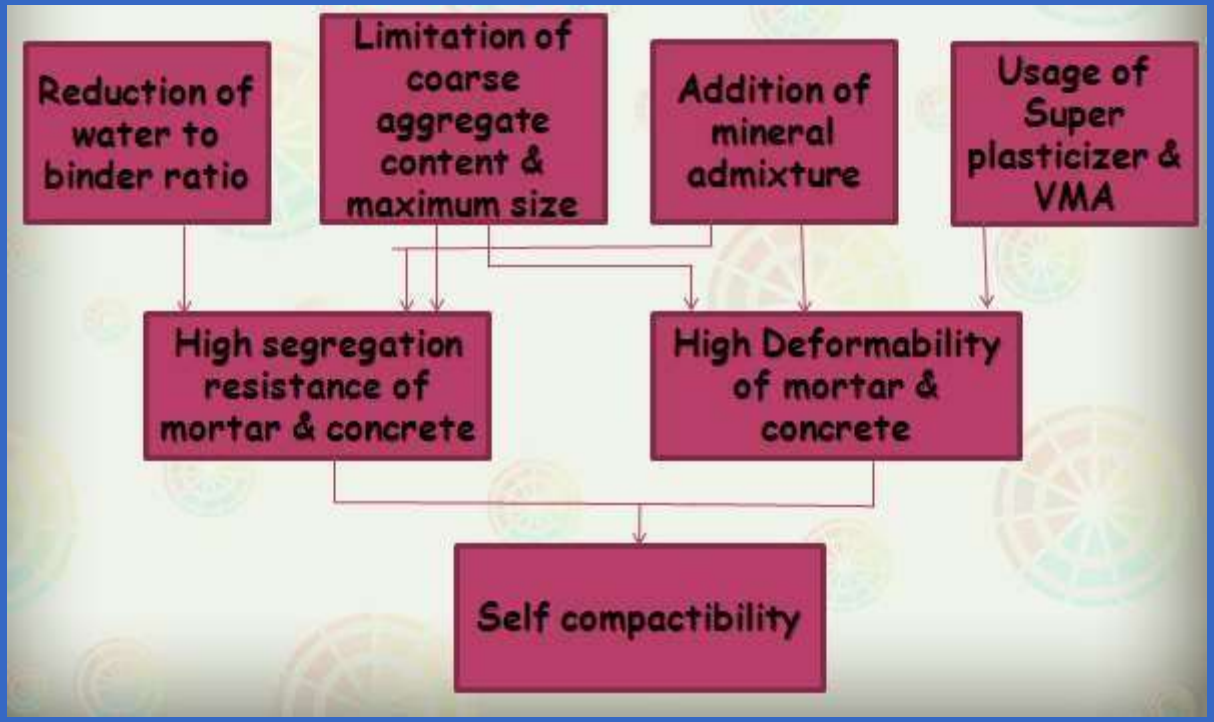
Scc should have:

- Air content is taken as 2%
- Low coarse aggregate content
- Increased paste content
- Low water powder ratio
- Increased super plasticizer dosage

EXAMPLES OF SCC MIXES

- POWDER TYPE : powder type scc is made by increasing the powder content.
- VMA TYPE : In this type viscosity modifying agent is added for seggregation resistance.
- COMBINED TYPE : Both powder and viscosity modifying agent is added

MECHANISM FOR ACHIEVING SELF COMPACTION



TESTS CONDUCTED ON SCC

The tests are not standardized till now.

- Slump flow test
- T_{50} slump flow test
- V-funnel test and v-funnel test at T_5 MIN
- L-Box test
- U-Box test
- Fill box test
- GTM screen stability test
- Orimet test

SLUMP FLOW TEST

- This test is done to know the horizontal flow of concrete in the absence of obstructions.
- It gives good assessment of filling ability.
- This test can be done in the field itself

PROCEDURE:

*A normal slump cone and a flat square plate is taken . Some concentric circles are drawn on square plate . A firm circle of 500 mm dia is drawn.

*The slump cone is filled with about 6litre of concrete and is raised vertically and allow the concrete to flow free in horizontal direction.

*Measure the final dia of concrete in 2 perpendicular directions and note the average of two diameters.

ACCEPTABILITY:

- ✓ The higher the flow rate , the grater is the ability to fill form work
- ✓ A value of at least 650 mm is required for scc.

T_{50} SLUMP FLOW TEST

- The procedure for this test is as same as for slump flow test.
- When the slump cone is lifted , start the stop watch and find the time taken for concrete to reach 500 mm mark.
- This time is called as T_{50} time.
- A lower time indicates greater flowability.
- It is suggested that T_{50} time may be 2 to 5 seconds.

J-RING TEST

- It denotes the passing ability of concrete.
- The equipment consists of a rectangular section and a ring of reinforced bars with holes.

PROCEDURE :

*A slump cone is taken and is filled with 6 litres of concrete.

*Raise the cone vertically and allow the concrete to flow through the j-ring.

*Measure the final diameter in 2 perpendicular directions and take the average value.

*Also measure the difference in height between the concrete just inside J-ring bars and just outside J-ring bars.

*Calculate the averge of difference in height at 4 loacations.

ACCEPTABILITY:

*The acceptable difference in height between inside and out side should be 0 to 10 mm.

V-FUNNEL TEST & V-FUNNEL AT T_5 MIN

*V-funnel test is used to find filling ability of aggregates of maximum size of 20 mm and v-funnel at T_5 min is used to find seggregation resistance

*The equipment consists of a v-shaped funnel

PROCEDURE FOR V-FUNNEL TEST :

*The door present below the v-funnel is closed and about 12 litre of concrete is poured inside.

*open the door within 10 seconds and record the time taken for concrete to flow down.

*The whole test is to performed within 5 minutes.

PROCEDURE FOR V-FUNNEL AT T_5 MIN :

*Do not clean or moisten the inside surface of funnel.

*Close the trap door and refill the v-funnel.

*Now open the trap door after 5 min and allow the concrete to flow down.

*Calculate the time taken for complete fall of concrete. It is called the flow time at T_5 min.

ACCETABILITY:

*For v-funnel test the flow time should be b/w 8to12min

*for v-funnel at T_5 min,+3 sec is allowed i.e.,11 to 15 min

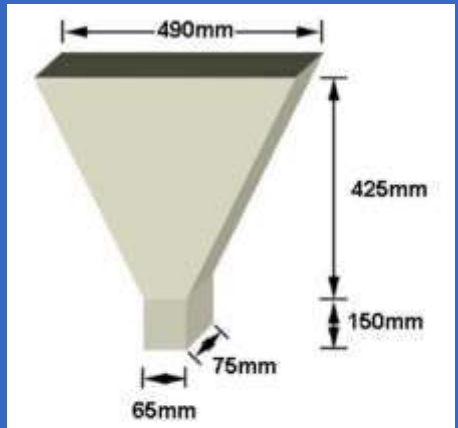


Figure 1.4 V-funnel (Dietz and Ma, 2000).

L-BOX TEST

*This test is used to know the passing ability of concrete.

PROCEDURE:

*About 14 litres of concrete is taken and fill the vertical section of L-BOX.

*Lift the gate and allow the concrete to flow out into the horizontal section.

*Start the stop watch and note down the time taken to reach 200 and 400mm marks.

*When the concrete stop flowing the heights H1 and H2 are measured.

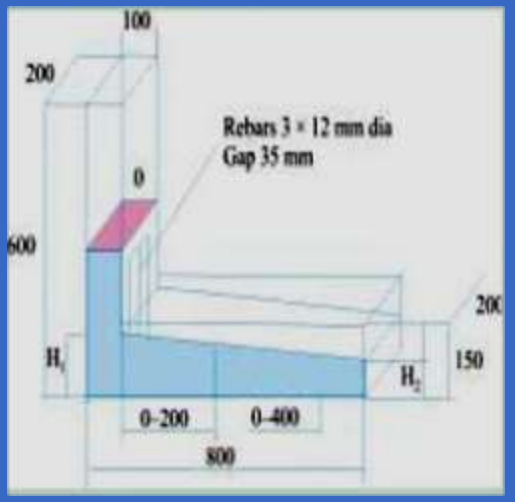
*Calculate blocking ratio H2/H1.

*The test is to be performed within 5 min.

ACCEPTABILITY:

*If the concrete flows like water then H2/H1=1

*The minimum acceptable value is 0.8.



U-BOX TEST

*This test is done to measure the passing ability of concrete.

PROCEDURE:

*About 20 litre of concrete taken and is poured on one of the side of u-box.

*Leave it stand for 1 min . Lift the sliding gate and allow the concrete to flow to other side.

*Once the concrete has come to rest measure the height of concrete at both sides.

*H1 is the height of concrete in 1st compartment

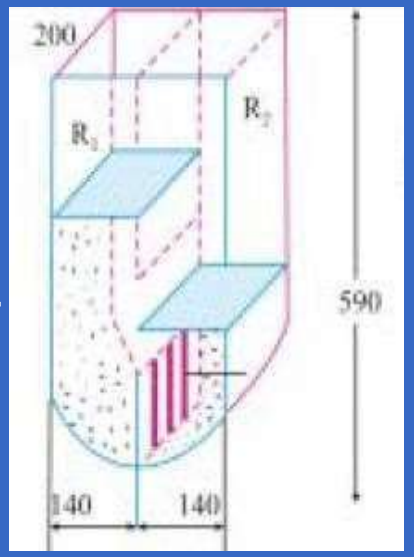
*H2 is the height of concrete in 2nd compartment

*Calculate the filling height H1-H2.The whole test is to be completed in 5 min.

ACCEPTABILITY :

*If the concrete flows like water , then H1-H2=0.It represents the better flow and passing ability of scc.

*The acceptable value is the filling height should not exceed 30 mm.



HOW ECONOMICAL IS SCC?

- The cost of scc is lower than normal concrete of high strength.
- The cost of construction of scc material is about 10-15% higher than normal concrete.
- But the cost of compaction , finishing etc will be low for scc and it leads to labour savings.

	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/ton	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
Superplasticizer	33/l	11.25	371	–	–
Retarder	50/l	1.35	68	1.725	86
VMA	40/l	–	–	0.575	23
Total			2928		3350
Cost over control					16.05 %

ADVANTAGES OF SCC

- Reduction in site manpower
- Problems caused by vibrators are reduced
- Easy to place
- Faster construction
- Better surface finish
- Improves durability due to better compaction and homogeneity of concrete

DISADVANTAGES OF SCC

- Higher paste volume results in greater shrinkage and creep.
- The mix design and procedure adopted is too complicated for practical implementation
- It requires more trial batches
- Costlier than conventional concrete based on materials(except placement costs)

CONCLUSION

- Self compacting concrete can save time , cost , enhance durability.
- Scc can be effectively transferred in congested reinforced areas such as columns , drilled shafts.

REFERENCES

- Concrete Technology (theory and practice) by M.S.Shetty , S.Chand publications.
- http://discovery.ucl.ac.uk/19028/1/19028.pdf
- http://www.ijtre.com/manuscript/2014010902.pdf