SELF COMPACTING CONCRETE

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DEFINITION

"Self-Consolidating Concrete (SCC) also known as self-compacting concrete, a highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight and adequately fill voids without segregation or excessive bleeding, and without the need for vibration.

Difference between SCC & Normal Concrete

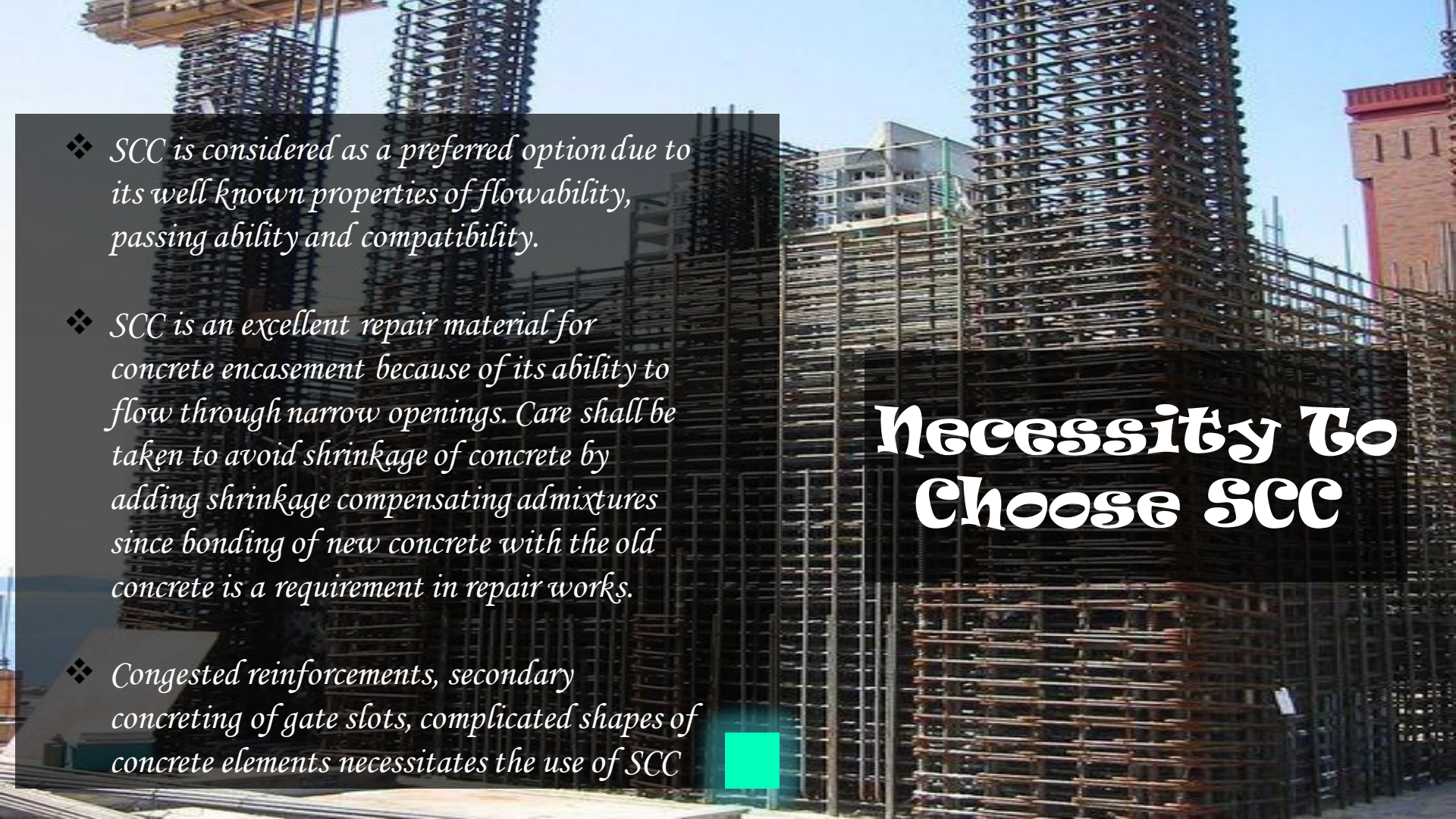
- *High workability*
- *Workability gained through superplasticizers*
- *Addition of superplasticizer increase the bond between aggregate and cement matrix.*
- *Water Content is Low*
- *Fines Content – Cement and Fine aggregate is high.*
- *Lower water content decreases the Bleeding*
- *Increased fines content gives a homogeneous mix with less segregation issues*
- *Low Viscosity due to high fines content*

- *Less workable mix*
- *Workability gained through increased moisture content*
- *The aggregate-cement matrix is weak*

- *High Water Content*
- *The fines content is less compared to SCC*
- *Bleeding is high*

- *Segregation is higher*

- *High Viscosity*

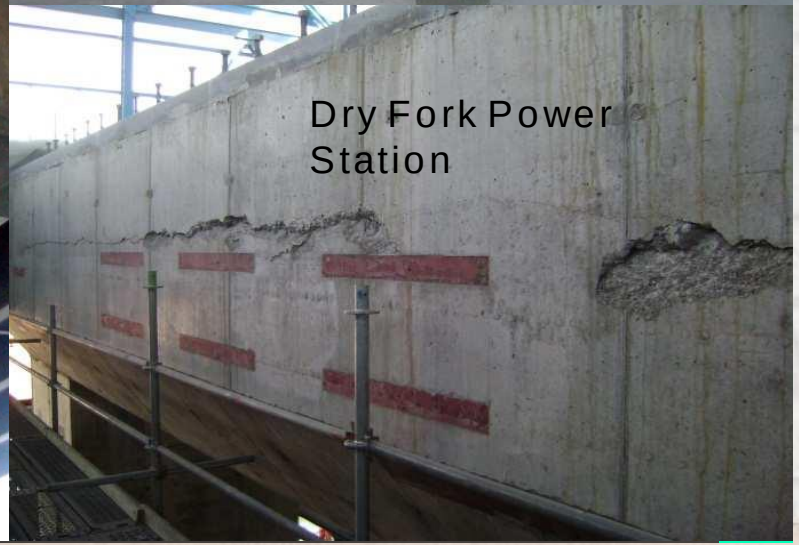


Necessity To Choose SCC

- *SCC is considered as a preferred option due to its well known properties of flowability, passing ability and compatibility.*
- *SCC is an excellent repair material for concrete encasement because of its ability to flow through narrow openings. Care shall be taken to avoid shrinkage of concrete by adding shrinkage compensating admixtures since bonding of new concrete with the old concrete is a requirement in repair works.*
- *Congested reinforcements, secondary concreting of gate slots, complicated shapes of concrete elements necessitates the use of SCC*


Beam &
Column Repair


Edge of joint
between two
slabs showed
wear and tear


Dry Fork Power
Station

MATERIALS USED FOR SCC

❖ **Cement:** *OPC of 43 or 53 grade can be used*

❖ **Aggregates:**

i. *Aggregate Of size ltd. to 20mm.*
ii. *Congested Reinforcement: 10 to 12mm*
iii. *Well graded cubical or rounded aggregates.*
iv. *Fine Aggregate can be either natural or manufactured and of uniform grade.*
v. *FA <0.125mm are considered as fines.*

❖ **Water:** *It must be of the same quality used for that of RC or Pre stressed concrete.*

o Chemical Admixtures:

The new generation super plasticizers termed as poly carboxylated ethers is particularly used.

- VMA : Modify the cohesion of the SCC
  - Reduce segregation & bleeding in SCC
  - Reduce friction & pressure in pumped conc.
- Retarders : To control setting time.
- Air Entraining Agents : To improve Freeze-Thaw resistance.

o Mineral Admixtures:

- GGBS : To improve Rheological Properties
  - Provides fines with a low heat of hydration
- Fly ash : To improve the quality and durability.
- Silica Fumes: To improve Mechanical Properties.
- Stone Powder: To increase the compressive strength.

DIFFERENT TESTS ON SCC

FILLING ABILITY TEST (Ability to flow into all spaces within the framework)	PASSING ABILITY TEST (Ability to flow through tight openings such as spaces between steel reinforcing bars)	SEGREGATION RESISTANCE TEST
Slump Flow Test	J-Ring Test	GTM Screen Stability Test
V-Funnel Test	U-Box Test	
Orimet Test	Fill-Box Test	
L-Box Test		

Slump flow test

- ✓ *(SF1) 500 - 650 mm is appropriate for slightly reinforced concrete (e.g.-tunnel linings and house slab.)*
- ✓ *(SF2) 660 - 750 mm is suitable for normal RC (e.g.- walls, columns)*
- ✓ *(SF3) 760 – 850 mm is used for vertical applications in very congested structures, structures with complex shapes.*

- ✓ *The slump flow test is done to assess the horizontal flow of concrete in the absence of obstructions.*
- ✓ *It is the most commonly used test at the site, the test also indicates the resistance to segregation and gives a good assessment of filling ability.*
- ✓ *When the slump cone is lifted, start the stopwatch and find the time taken for the concrete to reach a 500 mm mark. This time is called T_{50} time. This is an indication of the rate of spread of concrete.*
- ✓ ***The permissible range of values for slump flow is 650 mm to 800 mm.***

V-funnel test

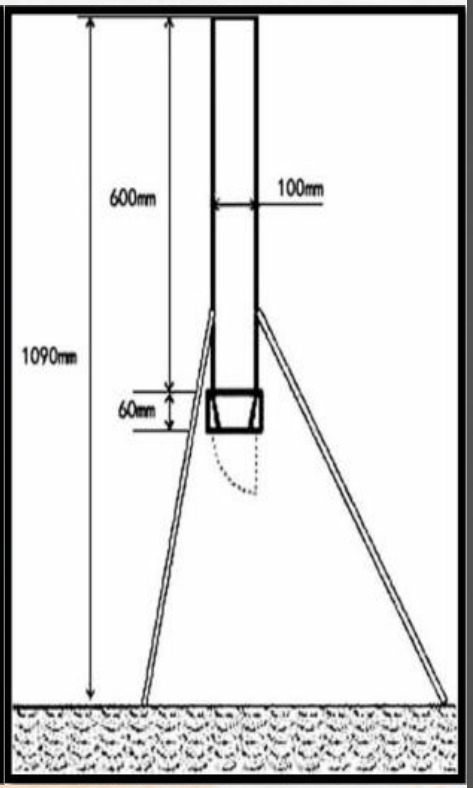
- ✓ *V- Funnel test is used to determine the **filling ability** (flowability) of the concrete with a maximum size of aggregate 20 mm size.*
- ✓ *The funnel is filled with about 12 liters of concrete, and left for 5 minutes to settle.*

After this, the trap gate is opened and the time taken for it to flow down is noted.

If the concrete shows segregation, then the flow time will increase significantly.

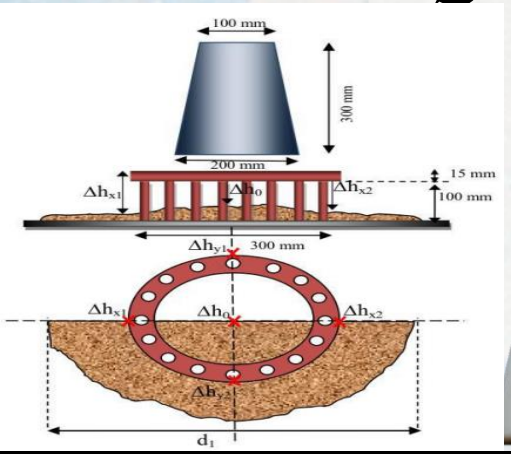
for V-funnel test the flow time should be between 8 and 12 seconds.

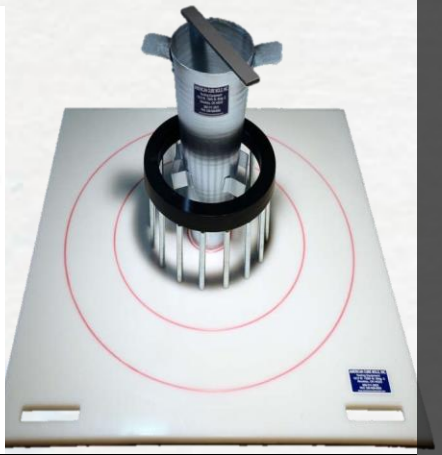
ORIMET test



- ✓ *The Orimet flow time is the period a defined volume of SCC needs to pass a narrow opening (a tube narrowed by an orifice).*
- ✓ *Orimet, made of steel, with the tube of a length of 600 mm and an inner diameter of 120 mm. The orifice, which narrows the opening of the tube and shears SCC, is interchangeable; its diameter can be chosen according to the mixture composition and the criteria on SCC.*
- ✓ *The flow time of the Orimet test is to some degree related to the plastic viscosity. Acceptance criteria for SCC is (0 – 5) sec.*

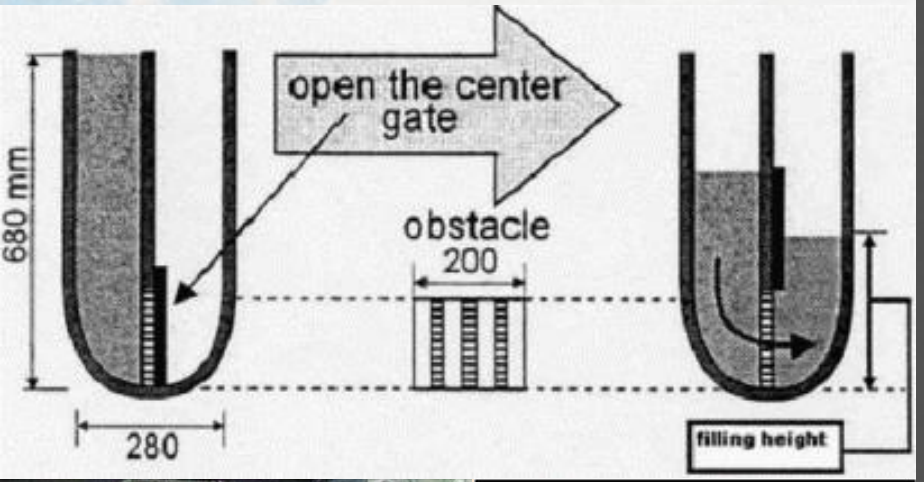
J-ring test

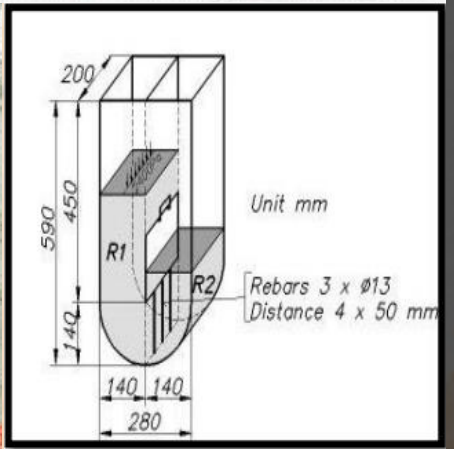




- *It is also a common test method at site. For this test, the slump test apparatus is used with an open steel rectangular section ring with 16 steel rods (ϕ16 mm).*
- *The gap between the bars is 42 mm.*
- *Wider gaps can be used when fibres are introduced to the mix which should be 1-3 times the maximum length of fibres used. The diameter of the ring formed by vertical sections is 300 mm and height 100 mm.*
- *The blocking step should be less than 10 mm.*

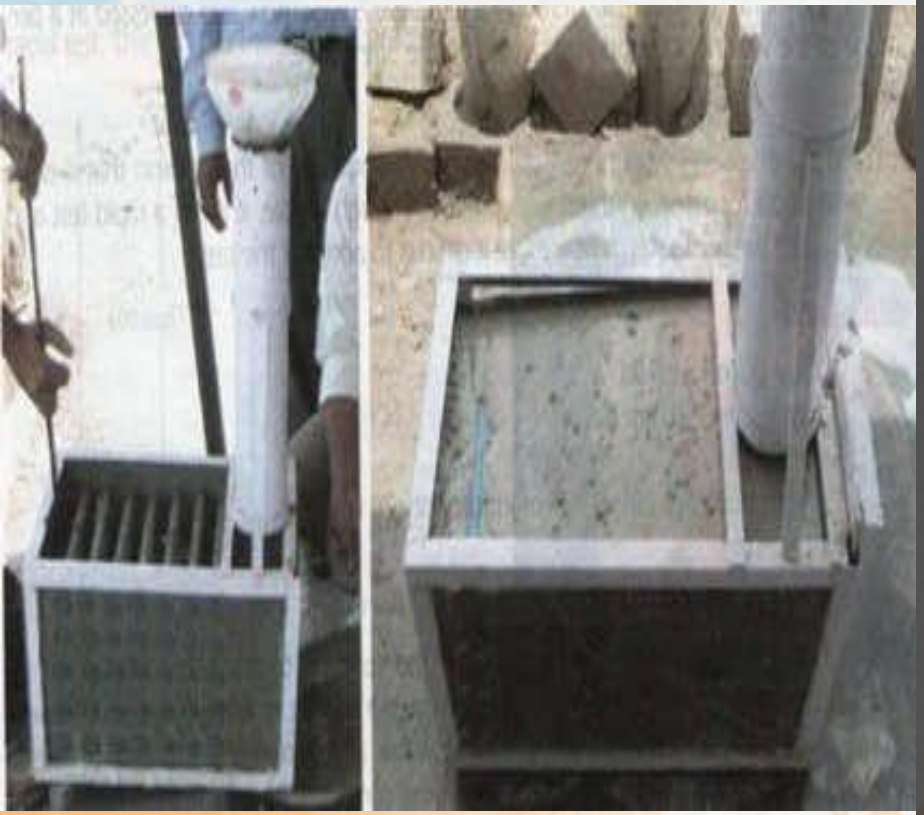
U-box test





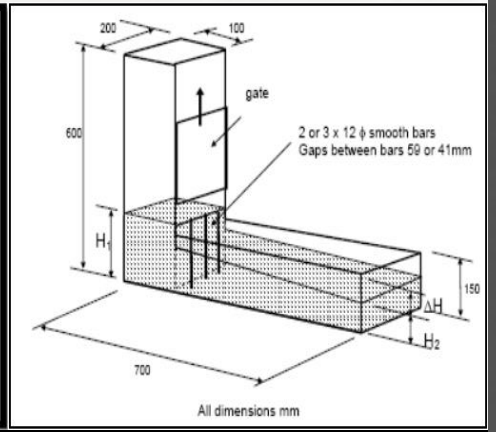
- ✓ *The test is used to measure the **filling ability** of self-compacting concrete.*
- ✓ *It consists of a vessel that is divided by a middle wall into two compartments This is a simple test to conduct, but the equipment may be difficult to construct.*
- ✓ *It provides a good direct assessment of filling ability.*
- ✓ *If the concrete flows as freely as water, at rest it will be horizontal, so H1 - H2 = 0. Therefore, the nearer this test value, the 'filling height', is to zero, the better the **flow and passing ability** of the concrete.*

Fill box test



- *The test is used to measure the **filling ability** of self-compacting concrete with a maximum aggregate size of 20mm.*
- *It consists of a container (transparent) with a flat and smooth surface, a container is filled with concrete through this filling pipe and the difference in height between two sides of the container is a measure for the filling ability.*
- ***Even a concrete mix with a high filling ability will perform poorly if the passing ability and segregation resistance are poor,** it is complex and difficult to perform on-site hence not used commonly.*
- *Average filling %: F= {(h1+h2)/ 2*h1} * 100%*

L-box test



- ✓ *The L-box test is used to assess the filling and passing ability of SCC, or in other words the ability of concrete to pass though reinforced bars without blocking or segregation.*
- ✓ *Fill the vertical section of the apparatus with about 12L of the concrete sample.*
- ✓ *Leave it to stand for 1 minute.*
- ✓ *Start the stopwatch and record the times taken for the concrete to reach the 200 and 400 mm marks.*
- ✓ *When the concrete stops flowing, the distances "H1" and "H2" are measured.*
- ✓ *Calculate H2/H1, **the blocking ratio**. The whole test has to be performed within 5 min.*

GTM Screen Stability Test

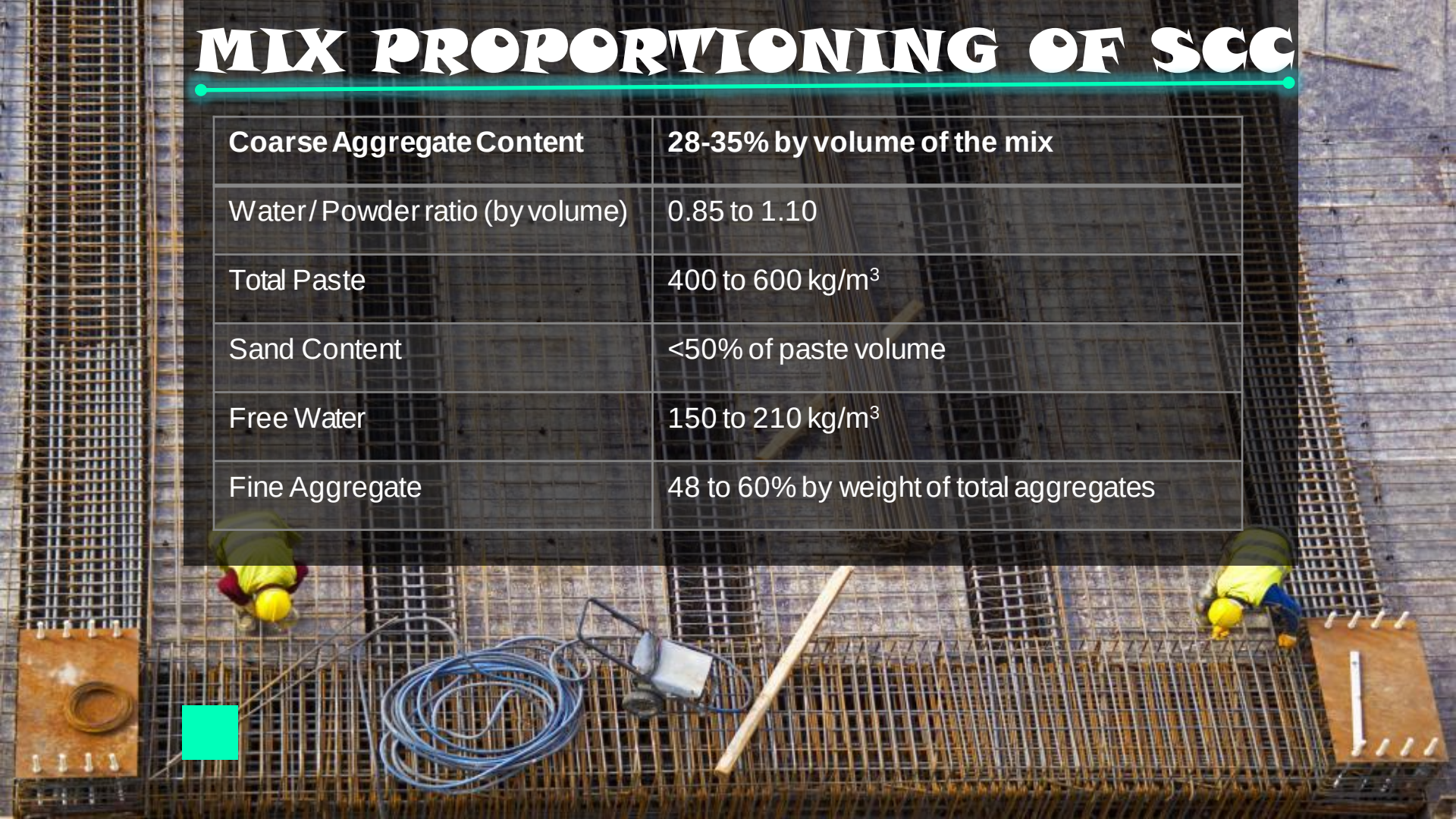
- ✓ *GTM screen stability can be used to check the segregation resistance of SCC.*
- ✓ *The method consisted of taking 10 L of concrete and allowing concrete to stand for 15 min in a bucket covered with a lid to prevent evaporation.*
- ✓ *After that, half of the concrete was poured onto a 350 mm diameter sieve, which sat on a sieve pan on a weighing scale. After 2 min, the mass of mortar that passed through the sieve was measured and expressed as a percentage of the weight of the original sample on the sieve.*
- ✓ *SR = (Wps – Wp) 100 / Wc %.*

LIMITS OF VARIOUS TESTS

Slump Flow Test	650mm to 800mm
V-Funnel Test	8sec to 12sec
Orimet Test	0sec to 5sec
J-Ring Test	0 to 10mm
U-Box Test	H2-H1=30mm max.
Fill Box Test	90% to 100%
L-Box Test	H2/H1=0.80 to 1.0
GTM Screen Stability Test	0 to 15%

MIX PROPORTIONING OF SCC

Coarse Aggregate Content	**28-35% by volume of the mix**
Water / Powder ratio (by volume)	0.85 to 1.10
Total Paste	400 to 600 kg/m^3
Sand Content	<50% of paste volume
Free Water	150 to 210 kg/m^3
Fine Aggregate	48 to 60% by weight of total aggregates



MIX DESIGN PROCEDURE

- *Determine The Desired Water Content*
- *Determine The Coarse Aggregate Volume*
- *Determine The Sand Content*
- *Determine The Paste Content*
- *Determine The Optimum Water to Powder Ratio and super plasticizer quantity in mortar*
- *Finally the concrete properties are assessed by the standard tests.*

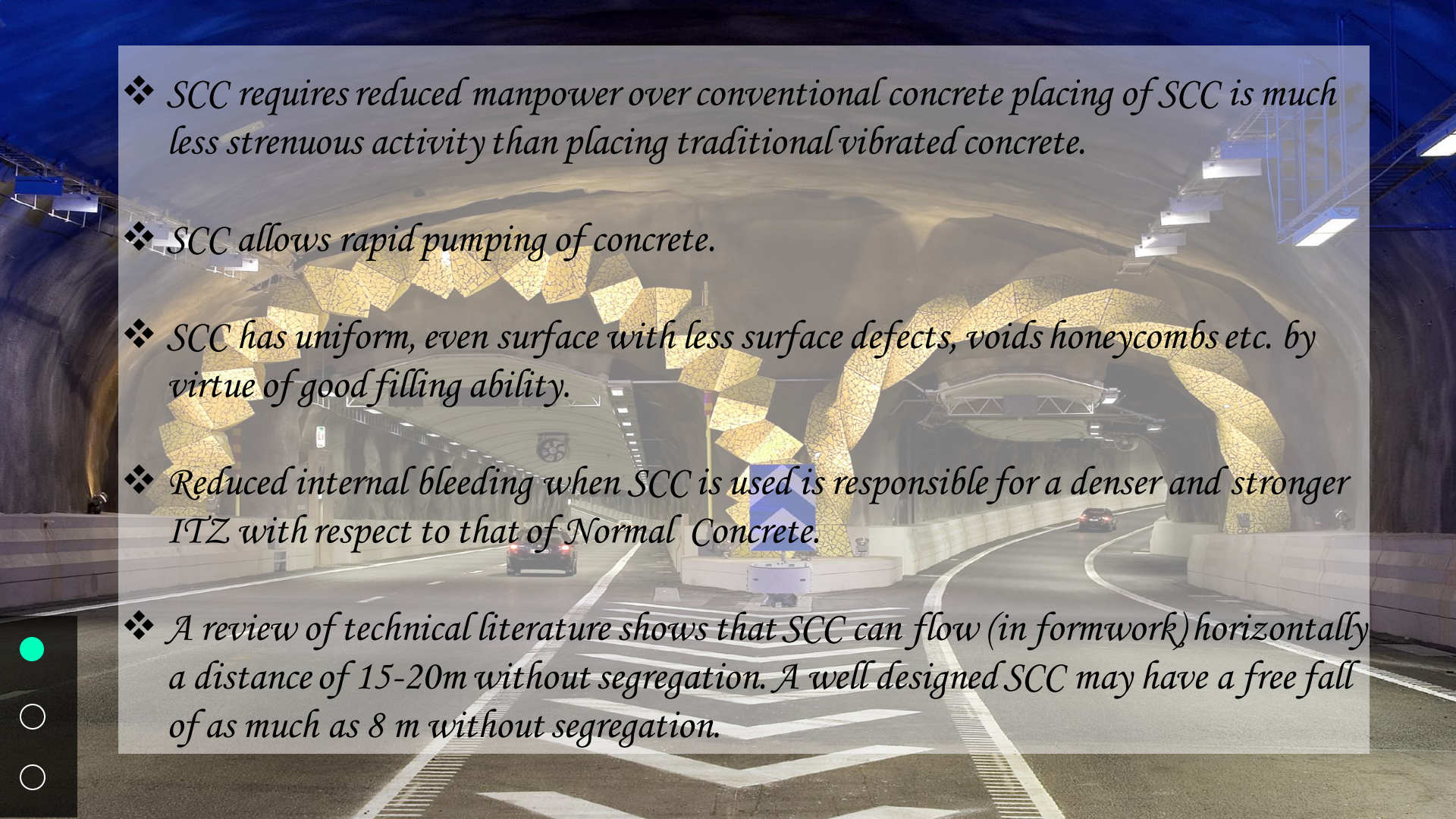
Advantages of SCC

- *Self compacting concrete offers a rapid rate of concrete placement with faster construction times & ease of flow around congested reinforcement. The fluidity & segregation resistance of SCC ensures a high level of homogeneity, minimal concrete voids & uniform concrete strength in situ, providing the potential for a superior level of finish & durability to the structure.*

- *It can be placed & compacted under its self weight with little or no vibration effort & which is at the same time is cohesive enough to be handled without segregation & bleeding.*

- *Use of fly ash in SCC is an eco friendly option and is useful in controlling the excess heat of hydration in concreting.*

- *SCC enables reduction in noise at site and so it ensures improved health and safety at site. The use of SCC reduces the exposure of the workers to sound intensities that are as low as one tenth of those produced when placing traditional vibrated concrete.*



- *SCC requires reduced manpower over conventional concrete placing of SCC is much less strenuous activity than placing traditional vibrated concrete.*
- *SCC allows rapid pumping of concrete.*
- *SCC has uniform, even surface with less surface defects, voids honeycombs etc. by virtue of good filling ability.*
- *Reduced internal bleeding when SCC is used is responsible for a denser and stronger ITZ with respect to that of Normal Concrete.*
- *A review of technical literature shows that SCC can flow (in formwork) horizontally a distance of 15-20m without segregation. A well designed SCC may have a free fall of as much as 8 m without segregation.*

Limitations of SCC

- *Requires well maintained and high degree of quality control & quality assurance methods. Production and placing of SCC need to be carried out by trained personnel only.*
- *The lower MSA (nominal maximum size of aggregate) and reduction in % of coarse aggregate in volume of SCC are responsible for lower modulus of elasticity compared to the conventional concrete. For this reason, the total shrinkage of SSC is also slightly higher.*
- *SCC requires good and leak proof formwork due to presence of more fines and flowable concrete. Special attention is needed in design of the formwork for pressures based on the flowability, cohesiveness, rate and method of placing or pumping.*
- *SCC is more sensitive to temperature during the hardening process than the conventional vibrated concrete hence extra care shall be taken about the handling and keeping the concrete cool.*
- *Because of high cementitious content, the control on temperature of concrete is highly important in extreme hot environment.*

- *Absence of internal and external bleeding in SCC, however, is one of the causes of their higher plastic shrinkage compared to traditional vibrated concrete. Hence, SCC should be cured as soon as practicable after placement to prevent surface shrinkage cracking.*

- *SCC mix requires a large number of trial batches. In addition to the laboratory trial batches, field trial batches should be used to simulate the typical production conditions.*

- *A change in the characteristics of a SCC mix could be a warning sign for quality control.*


thank you!
Meals
Kitchen
Bed 2
Bath
Bed 1
Spa
Deck
Sauna
Entry 2
Bed 3
Porte cochere
Entry
Family
Patio
Living
Garage
Store
Floor Plan