BW001
TECHNOLOGY OF CONSTRUCTIONS I

6th WEEK

CONCRETE

CONCRETING TECHNIQUES, VIBRATION AND BASIC MACHINES

INTRODUCTION

- **CONCRETE**
  - Concrete is a composite material in which a binding material mixed in water on solidification binds the inert particles of well graded fine and coarse aggregates.
  - **Cement and lime are generally used as binding materials**, whereas sand cinder is used as fine aggregates and crushed stones, gravel, broken bricks, clinkers are used as coarse aggregates.

+ Concrete can handle the compression stresses 10 times more than the tension and the most of loads in our life is compression.
+ Concrete is a brittle material which gives the advantage to make a rigid structure.
+ Easy to handle over specially now there is plants that give you ready mix concrete.

– Concrete is weak in handling tension.
– Because concrete is a brittle material the strength upon shear (specially at 45 degrees) must be checked.
– Needs another material to reinforce it against excessive shear and tension.

INTRODUCTION

- **PLACING CONCRETE**
  - The main objective in placing is to deposit the concrete as close as possible to its final position as quickly and efficiently as you can, so that segregation is avoided and it can be fully compacted.
  - Concrete can be transported by a variety of different methods ranging from wheelbarrows, dumpers and ready-mix trucks to skips and pumps, and though it is obviously desirable to place the concrete directly into position this is not always possible: for example, it will seldom be practical to discharge from a dumper or ready-mix truck directly into the top of a column or wall.

MIXERS

- There are two main categories of mixer:
  1. batch mixers and
  2. continuous mixers.

- The first type of mixer produces concrete one batch at a time, while the second type produces concrete at a constant rate.
- The first type needs to be emptied completely after each mixing cycle, cleaned (if possible), and reloaded with the materials for the next batch of concrete.
- In the second type, the constituents are continuously entered at one end as the fresh concrete exits the other end.

BATCH MIXER

- Two main types of batch mixer can be distinguished by the orientation of the axis of rotation: horizontal or inclined (drum mixers) or vertical (pan mixers).
- The drum mixers have a drum, with fixed blades, rotating around its axis, while the pan mixers may have either the blades or the pan rotating around the axis.

- https://www.youtube.com/watch?v=r9SqtvvGHsg

MIXERS

DRUM MIXER

- All the drum mixers have a container.
- The blades are attached to the inside of the movable drum.
- Their main purpose is to lift the materials as the drum rotates.
- In each rotation, the lifted material drops back into the mixer at the bottom of the drum and the cycle starts again.
- Parameters that can be controlled are the rotation speed of the drum and, in certain mixers, the angle of inclination of the rotation axis.

- <u>There are three main types of drum mixers:</u>
  - non-tilting drum;
  - reversing drum;
  - tilting drum.

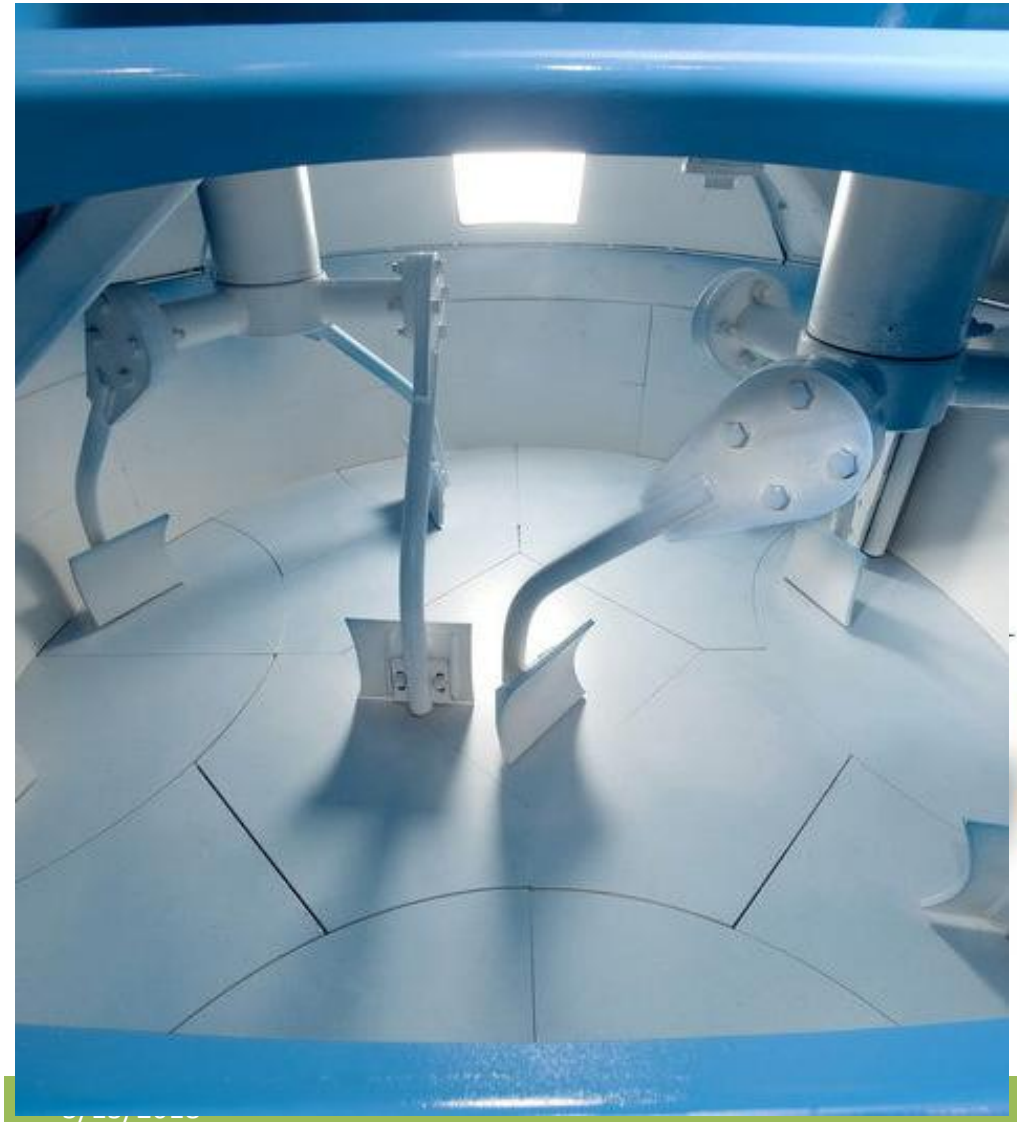
MIXERS

DRUM MIXER

- The non-tilting drum mixer implies that the orientation of the drum is fixed.
- The materials are added at one end and discharged at the other .
- The reversing drum is similar to the non-tilting mixer except that the same opening is used to add the constituents and to discharge concrete.
- The drum rotates in one direction for mixing and in the opposite direction for discharging the concrete.
- There are two types of blades attached to the inner walls of the drum. One set drags the concrete upwards and toward the center of the mixer when the drum rotates in one direction; the second set of blades pushes the concrete toward the opening when the drum rotates in the other direction.
- The blades have a spiral arrangement to obtain the desired effect for discharge and mixing.

MIXERS

PAN MIXER



MIXERS

CONTINUOS MIXERS

- The second category of mixers is continuous mixers.
- As the name indicates, the materials are continuously fed into the mixer at the same rate as the concrete is discharged.
- They are usually non-tilting drums with screw-type blades rotating in the middle of the drum. The drum is tilted downward toward the discharge opening. The mixing time is determined by the slope of the drum (usually about 15 degrees).
- These mixers are used for applications that require a short working time, long unloading time, remote sites (not suitable for ready-mix) and/or small deliveries.
- A major use of these types of mixers is for low slump concrete.

CONCRETE MIXING TRANSPORT TRUCKS

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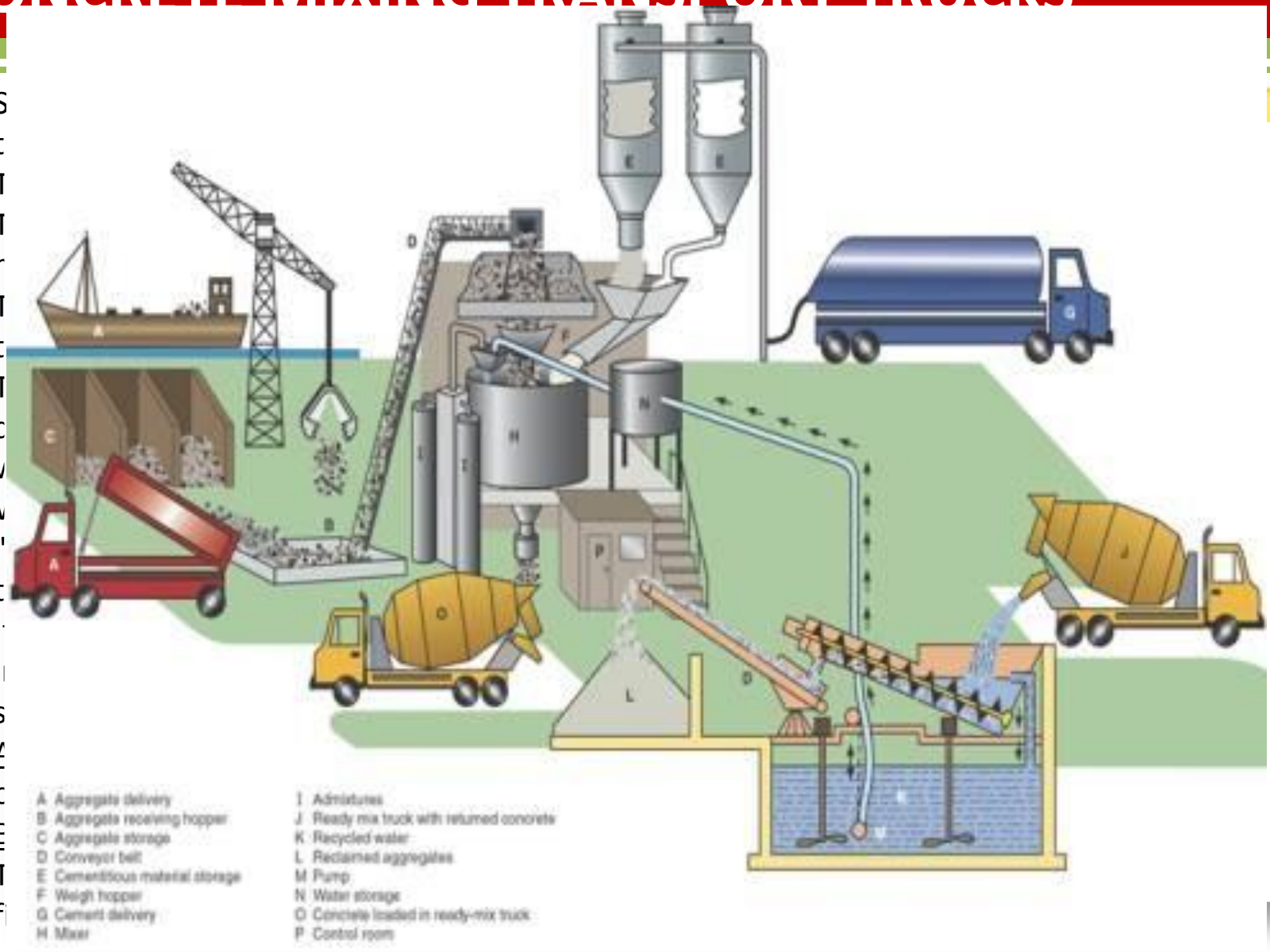

PUMPED CONCRETE

- A concrete which can be pushed through a pipeline is called pumpable concrete.
- The Concrete mix is designed in such a manner that it does not wedge while flowing and its friction at the inner wall of the pipe line does not become very high.
- Pumpable concrete emerging from a pipeline flows in the form of a plug which is separated from the pipe wall by a thin lubricating layer consisting of cement paste. The water in the paste hydraulically linked with the interparticle water layer in the plug. Fig shows the flow of concrete under pressure. For continuous plug movement, the pressure generated by the flow resistance must not be greater than pump pressure rating. However, if w/c ratio is high, the concrete becomes too saturated and water is forced out of the mix, creating an increase in flow resistance and a possible blockage of concrete.
- Thus, a very stiff concrete is not pumpable and also a concrete with w/c ratio is also not pumpable.
- It is interesting to note that if a concrete is pumpable, it implied that it is a good concrete.

- https://www.youtube.com/watch?v=Puxt1c7GoDs
- https://www.youtube.com/watch?v=_GDSnb4xHRc

CONCRETE PUMP

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em.

above systems. Suitable for high-rise

CONCRETing

- Someone experienced in the construction of formwork, preferably a tradesman, should always be standing by when the concrete is being placed.
- He should have a supply of suitable materials such as props, bolts etc. to handle dangerous situations.
- Grout loss is an indication that joints were not tight or some movements has occurred during placing.
- The vibrations transmitted to the formwork can loosen wedges and fixings so a close watch on all fastenings is necessary to avoid loosening. Similarly, wedges should be regularly checked and tightened.
- All split concrete or grout leakage should be cleaned or diluted with spray water immediately after concreting to make striking and cleaning easier especially with steel formwork.
- Remove timber spreaders which were used to hold formwork apart as concreting proceeds.
- Check cracking, excessive deflection, level and plumb, and any movement.
- Concrete should be deposited at/or as near as possible to, its final position.

CONCRETing

- The concrete should be placed in uniform layers. Avoid placing it in large heaps or sloping layers because there is always a danger of segregation, especially with mixes tending to be uncohesive.
- In walls and columns no layer should be more than about 450 mm thick!!! With layers thicker than 450 mm, the weight of concrete on top makes it almost impossible-even with vibration-to get the air out from the bottom of the layer.
- In thin slabs compacted by a vibrating beam, restrict the layers to 150-200 mm. With greater thickness, vibrators have to be used.
- Place the concrete as quickly as possible. But not faster than the compacting method and equipment can cope with.
- Where a good finish is required on columns and walls, fill the forms at a rate greater than 2 metres height per hour. Also avoid delays and interruptions because these will cause colour variations on the surface.

CONCRETing

- Make sure that each layer of concrete has been fully compacted before placing the next one, and that each new layer is placed while the underlying layer is still responsive to vibration. This will make the layers "knits" together.
- Avoid the formation of cold joints. Good planning is necessary, particularly with large pours.
- In columns and walls, the placing must be done in such a way that the concrete does not strike the face of the formwork; similarly, avoid heavy impact against reinforcement, as the force could displace it.
- Always make sure that the concrete can be seen as it is being deposited.

COMPACTING CONCRETE

- After concrete has been mixed, transported and placed, it contains entrapped air in the form or voids.
- The object of compaction is to get rid of as much as possible for this unwanted entrapped air; down to less than 1% is usually the aim.
- The amount of entrapped air is related to the workability:
  - concrete with a 75 mm slump contains about 5 % air,
  - while concrete of 25 mm slump contains about 20 %.
  - This is why a low-slump concrete requires more compactive effort-either a longer time or more vibrators compared with a concrete with a higher slump.

SLUMP

- The target is a slump of 25% to 50% of the original height.
- If there is no slump, the concrete will be too dry to work.
- More than 50% slump is too wet and the mix will not have the necessary strength.
- Insufficient slump can be remedied by adding more water but excessive slump usually requires that the mix be discarded.

1. Fill Co
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REASONS FOR REMOVING AIR

- Voids reduce the strength of the concrete.
- For every 1 % of entrapped air, the strength falls by about 5 to 6 %. So a concrete with, say, 3 % voids will be about 15-20 % weaker than it should be.
- Voids increase the permeability, which in turn reduces the durability.
- If the concrete is not dense and impermeable, it will not be watertight, it will be less able to withstand mildly aggressive liquids, and any exposed surfaces will weather badly; in addition, moisture and air are more likely to get to reinforcement and cause it to rust.
- Voids reduce the contact between the concrete and the reinforcement and other embedded metals; the required bond will then not be achieved and the reinforced member will not be as strong as it should be.
- Voids produce visual blemishes such as blowholes and honeycombing on stuck surfaces.
- Fully compacted concrete will be dense, strong, durable and impermeable.
- Badly compacted concrete will be weak, non-durable, honeycombed and porous.
- The air must be removed!

VIBRATION

- Rodding and spading are all ways of removing air from concrete to compact it, but the best and quickest method is vibration.
- When a concrete mix is vibrated it is "fluidized", which reduces the internal friction between the aggregate particles.
- The fluidization of concrete allows entrapped air to rise to the surface, and the concrete becomes denser.
- With a properly designed cohesive mix, segregation and bleeding will be minimised.
- With an over-wet mix, the larger aggregate pieces may settle during compaction, with the result that a weak layer of laitance (= cement milk) will finish up on the surface; if this does happen, the laitance must be removed.
- It therefore pay to see that mix is right in the first place!

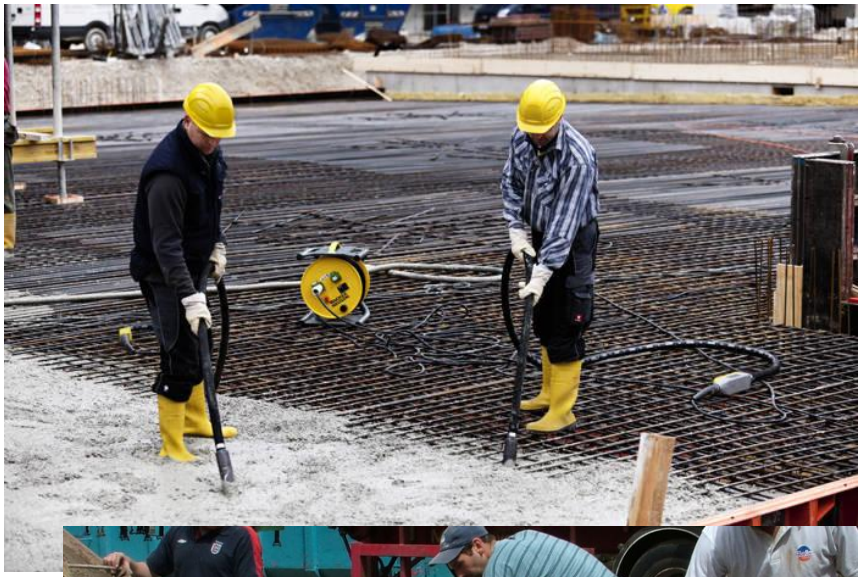
VIBRATORS

- These are mobile items of mechanical plant used to vibrate (shake) air out of fresh concrete.
- **There are 2 major types of vibrators:**
  - External vibrators (Form vibrators)
  - Internal vibrators (Poker/Immersion vibrators)
- **All types of vibrators have motors, which can be driven by:**
  - Compressed air
  - Main supply electricity (230 or 400V & 50Hz) motors
  - High frequency electricity motors
  - Petrol or diesel (liquid fuel)

INTERNAL VIBRATOR USAGE

- Internal vibrators are often used inefficiently.
- They often run wastefully, or at a reduced efficiency, for about 70% of their operating time, this being made up as follows:
  - out of the concrete and left running 15%
  - wrongly positioned in the concrete 35%
  - vibrating already compacted concrete 20%
  - Total: 70%

- This means that the poker is doing useful work for only 30% of the time, which is why it is so necessary to plan the compaction in advance, along with the placing method and technique, so that both operations are done as economically and as quickly as possible.



RULES FOR USING INTERNAL VIBRATORS

1. Make sure you can see the concrete surface. Lights may be required in thin deep sections.
2. Put the head in quickly. When inserting the poker, allow it to penetrate to the bottom of the layer as quickly as possible under its own weight. If done slowly, the top part of the layer will be compacted first, making it more difficult for the entrapped air in the lower part of the layer to escape to the surface.
3. Insert the head vertically. This minimizes the voids created by inserting the head, and allows air bubbles to rise up unimpeded by a slopping vibrator.
4. Do not stir. This only increases the voids.
5. Leave the poker in the concrete for about 10 seconds.
6. Withdraw the poker slowly. The main thing is to see that the hole made by the poker is closed up; otherwise you will be left with a hole in the finished concrete. If this does happen-and it is often difficult to prevent if the concrete is very stiff-put the poker back in near enough to the hold for the next spell of vibration to close it up. For the final insertion, withdraw the poker even more slowly and wiggle it about to ensure that the hole closes up properly.
7. Repeat insertion. Ensure that in plan (as seen on the surface) all areas covered.
8. Avoid touching the form face with the poker. Not only will the form face be damaged but a mark will be left on the finished concrete surface. To be on the safe side, keep the vibrator about 75-100 mm from the formwork.

RULES FOR USING INTERNAL VIBRATORS

9. Avoid touching the reinforcement with the poker. Provided that all the concrete is still fresh, vibrating the reinforcement should not do any harm and could improve the bond. The danger lies in the vibrations in the reinforcement being transmitted into parts of the section where the concrete may have stiffened, in which case the bond may be affected.
10. For shallow flat slabs lie the head in the concrete and drag the head slowly through the concrete. Alternately an external vibrator may be able to be used. If say of the head can be immersed, the vibrator will not be very effective, and compaction will be slow.
11. Avoid using the vibrator to make the concrete flow. You may get some areas of segregation and other areas of fines only concrete. The latter may be weak and cause discoloration.
12. Avoid sticking the poker into the top of a heap. Although heaps should be avoided in placing they are sometimes unavoidable or caused by mistake. To flatten a heap, insert the poker around the perimeter. Do this carefully to avoid segregation.
13. Make sure that the poker extends about 100mm into any previous layer. This will knit the layers together, and any laitance on top of the previous layer will be mixed with the bottom of the new one. The new layer should not yet of course be rigid.
14. The maximum depth of the new layer equals vibrator head length minus 100 mm. If the depth of concrete is greater, then the new part will not be fully compacted.

RULES FOR USING INTERNAL VIBRATORS

15. Put the whole length of the poker into the concrete. This is essential to keep the bearings cool.
16. Avoid leaving the poker running when it is not in the concrete. Otherwise there is a risk of bearings overheating.
17. Avoid sharp bends in flexible drives. Otherwise the shaft can be broken.
18. Remember that, where finish is important, a little bit of extra vibration can reduce the number of blowholes.
19. Make sure the drive motor will not vibrate itself off the staging. Do not remove it by pulling the flexible drive.
20. Clean it afterwards.

LENGTH OF TIME REQUIRED FOR FULL COMPACTION

- Initial consolidation is rapid and the level of the concrete drops, but the entrapped air has still to be removed.
- As the concrete is vibrated, air bubbles come to the surface. When the bubbles stop it can be taken as a sign that not much more useful work can be cone on the concrete. The distance of the bubbles from the poker is also a useful guide to its radius of action.
- Sometimes the sound of the poker can be a helpful guide. When the poker is inserted there is usually a dropping off in frequency, and when the pitch (whine) becomes constant the concrete is free of entrapped air.
- The surface appearance also gives an indication of whether or not compaction is complete. A thin film of glistening mortar on the surface is a sign that the concrete is compacted, as is cement paste showing at the junction of the concrete and formwork.

REVIBRATION

- On columns and walls where surface finish is of importance, there is sometimes a tendency for blowholes to occur in the top 600 mm of a lift; the reason is that, unlike the lower layers, this to the weight of additional concrete
- It can oft fter the initial compact
- In thick s e to bleeding, there is a ction.
- If they ar able, revibrati

CURING

- It is important to not allow a placed concrete batch to dry too fast.
- The water must combine with the cement to form the concrete.
- If the water evaporates before the concrete has formed (been cured) the resulting mix may be under strength.
- This is often a particular concern with slab construction since so much of the slab is exposed to the air and the sun.

- Curing is the process of keeping the concrete damp to allow hardening at the proper rate.
- This is a critical concern in hot, dry climates.
- An approach that is typically employed on limited resource projects is to cover the placed concrete with plastic, burlap bags, or damp straw. Jute or burlap sacks can be wrapped around columns and wetted.
- In damp areas such as rainforests, the ambient moisture may be sufficient.
- Within 24 hours, the slab can be walked on.
- Curing is generally complete in 3 to 7 days.

CURING

- Generally, a properly mixed concrete will be waterproof.
- However a sealant is often applied especially if there is a concern about small cracks forming during curing.
- It is applied after curing is complete.
- If a sealant is used, it is important to assure that it is not toxic.
- Proper ventilation is also necessary if sealing within a closed tank.
- A cement-sand slurry can be used to seal small cracks if a commercial sealant is not available.

CONCRETE STRENGTH

- A 3:2:1 mix with a strong aggregate and low w/c ratio will produce a very strong concrete (more than 28 MPa) .
- However, designers are discouraged from assuming this high strength is readily accomplished in resource limited conditions.
- Given the inherent uncertainties in cement quality and propensity for inexperienced construction crews to add more water than is ideal, it is generally assumed that concrete strength is in the 20,68 MPa range for design purposes.
- Where resources are very limited and quality control on both the aggregate and mix can be especially problematic, it is safer to assume that an even lower concrete strength is achieved.

REFERENCES

- http://www.premix.com.au/about-us/concreting-tips-and-techniques/
- http://www.ewb-usa.org/files/EWB-USA-TP-103-Concrete-Construction-Field-Techniques-revc.pdf