NATIONAL READY-MIXED CONCRETE ASSOCIATION OF MALAYSIA (NRMCA)

COMMON CONCRETE DEFECTS HANDBOOK

CONTENTS

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1. Concrete Bleeding

All concrete bleeds and to a certain extent bleeding are beneficial as the bleed water will act as a protective layer to the freshly laid concrete and minimize the occurrence of plastic shrinkage cracks. However, excessive bleeding (Figure 1) will lead to subsequent defects such as crazing cracks, surface delamination etc.

Figure 1. Excessive Bleeding in Freshly Cast Concrete.

1.1 Likely causes:

- ✓ Excessive water added, excessive vibration or handling during placement of concrete
- ✓ Poor concrete mix design, poor gradation and proportioning of course and fine aggregates (S/A ratio)
- ✓ Materials cross contamination and poor mix design adherence which can be caused by storage bin overflows, improper stockpiling, and quality control processes, poor plant maintenance, and trucks tipping into the incorrect stockpile
- ✓ Storage bin partition worn out and lead to material mixed up in the storage bin
- ✓ Gap graded aggregates, particularly fine aggregates deficient in #50 to #100 sieve size
- ✓ Manufactured sands that are angular, coarse when use in a poorly designed mix
- ✓ High w/c in the concrete mix
- ✓ Overdose of plasticizer/water reducing admixtures
- ✓ Lack of air entraining characteristic in the concrete mix

1.2 Preventions:

- ✓ Avoid excessive vibration, particularly in air entrained concrete
- ✓ No water addition at any times after concrete batched from batching plant
- ✓ Proper adjustment in terms of S/A ratio in concrete mix design to prevent gap grading phenomena
- ✓ Blending sands to form more preferable gradations

- ✓ Avoid using coarse sands with FMs higher than 3.5
- ✓ Ensure proper stockpile partitioning to prevent cross contamination
- ✓ Periodic plant maintenance and inspection
- ✓ Install level sensor detection at material storage bin to prevent material overflow to the next storage bin
- ✓ Improving quality control and inspection process at storage bin and stockpile
- ✓ Use air entrainment admixture where applicable

Cross contamination in material storage hopper

Bleeding Test on fresh concrete mix (BS EN 480-4)

2. Concrete Segregation

✓ Separation of aggregate from cement paste and mortar as freshly casted concrete is placed into forms

2.1 Likely causes:

- ✓ Poor placement of concrete ie: over vibrating
- ✓ Excessively high slump or harsh (improper S/A ratio) concrete mixes
- ✓ Mixing inefficiency caused by insufficient mixing time or worn-out mixing blade
- ✓ Materials cross contamination and poor mix design adherence which can be caused by storage bin overflows, improper stockpiling, and quality control processes, poor plant maintenance, and trucks tipping into the incorrect stockpile

2.2 Preventions:

- ✓ No water addition at any times after concrete batched from batching plant
- ✓ Increase supervision and well-trained worker to carry out the placement of concrete
- ✓ Ensure proper stockpile partitioning to prevent cross contamination
- ✓ Improving quality control and inspection process at the storage bin and stockpiles
- ✓ Install level sensor detection at material storage bin to prevent material overflow to the next storage bin
- ✓ Periodic plant maintenance and inspection on mixer blade condition/speed
- ✓ Use air entrainment to minimize segregation in lean mixes
- ✓ Proper mix proportioning to improve mix cohesiveness

Indication of concrete segregation during slump

Level Sensor Detector

Hardened concrete defect (Honeycomb) due to concrete segregation

3. Concrete Pump Blockage

- ✓ Erratic flow or clogging of pump lines or pistons

3.1 Likely causes:

- ✓ Concrete pump not maintained, pump line blocked, concrete pump lacked of adequate pressure, water addition by site personnel to the delivered concrete
- ✓ Segregation of materials in the pump hopper or pipeline'
- ✓ Non-uniform feeding of fresh concrete into pump
- ✓ Excessively high or low concrete slump
- ✓ Harsh mixes caused by poor mix design
- ✓ Harsh or overly wet concrete

3.2 Preventions:

- ✓ Contractor to ensure pump is well maintained, site personnel ensure no water added on site and designated concrete slump is maintained
- ✓ Ensure the concrete pump line is adequately primed with cement slurry
- ✓ Ensure supplied concrete consistency is suitable for pumping purpose Protect pipeline from direct sunlight during hot weather concreting
- ✓ Keep pump hopper filled to ensure uniform delivery rate to pump and pipeline
- ✓ Thoroughly mix concrete to eliminate or minimize segregation before discharging into the pump concrete hopper
- ✓ Increase S/A ratio in concrete design mix to improve mix cohesiveness
- ✓ Ensure adequate paste volume or utilization of supplementary cementitious materials (GGBS & PFA)
- ✓ Utilization of slump retention chemical admixture in concrete mix design for maintaining concrete slump for the purpose ofpumping and placement
- ✓ Appropriate materials grading to prevent segregation and subsequent pump blockage

Figure 2. Concrete Pump Blockage at Construction Site

4. Concrete Slump Loss

4.1 Likely causes:

- ✓ Concrete truck awaiting too long at project site due to poor schedule of concreting
- ✓ Hot/dry materials especially 20mm aggregate and cement
- ✓ Weathering effect (Concreting during hot, high wind velocity and low relative humidity environment)
- ✓ Presence of excessive fine materials e.g., silt and clay in sand
- ✓ Low W/C design mix

4.2 Prevention:

- ✓ Improve communication between contractor and ready-mixed concrete supplier to avoid delay in concrete discharge on site (Hard to avoid daytime supply nowadays as customer all is rushing to finish their casting during daytime to avoid OT)
- ✓ Ensure aggregate stockpile is in saturated surface dry (SSD) condition by water sprinkling at the right interval
- ✓ Consider raw material (aggregate and sand) stockpile under sheltered condition
- ✓ Use of cold cement Avoid using hot or freshly pump cement by allowing freshly pump cement to cool down for 1-2 days by having adequate storage silos. If the above condition is not possible, consider using chilled water for concrete batching
- ✓ Increase W/C in concrete design mix
- ✓ Utilization of slump retaining chemical admixture or addition of retarder to improve concrete Slump retention
- ✓ Ensure adequate concrete mixing time

5. Low Cube Compressive Strength

5.1 Likely causes

- ✓ Improper handling of concrete cube during early age (first 24 hours) and during testing
- ✓ Improper sampling of fresh concrete during cube making process
- ✓ Uncontrolled water addition into the fresh concrete mix
- ✓ Poor materials quality such as cement, coarse aggregate, fine aggregate or chemical admixture
- ✓ Insufficient constituent materials in the mix due to poor quality control and/or plant issue caused by mechanical problem
- ✓ Materials contamination at the storage and weighing bin
- ✓ Poor maintenance of cube molds
- ✓ Unsatisfactory failure mode due to improper cube specimen preparation or compression machine problem

5.2 Prevention

- ✓ Ensure proper plant maintenance and scheduled calibration is performed
- ✓ Ensure the concrete is homogenously mixed
- ✓ Strictly follow the design water cement ratio
- ✓ Periodical inspection and testing of the incoming raw materials (cement, aggregates and chemical admixture)
- ✓ Ensure proper sampling of fresh concrete (homogeneous mixture of mortar and aggregate) during cube making process
- ✓ Periodical quality checking on cube molds condition
- ✓ Ensure freshly casted concrete cube is in undisturbed condition for at least 24 hours and ensure proper handling during demolding and transport process Ensure concrete cube is fully submerged in lime-saturated water for curing
- ✓ Ensure periodical calibration and maintenance for compression machine

Type of cracks					
Cracks occurring before hardening		Cracks occurring after hardening (after achieves final setting)			
Fresh concrete (while still in plastic state)		Young concrete (early age ie up to 28 days)		Matured concrete (> 28 days)	
Construction movement	Formwork movement	Volume changes	Autogeneous and drying shrinkage	Structural cracks	Design load/ accidental overload
	Subgrade movement				Fatigue
Plastic	Plastic shrinkage			Volume changes	Drying shrinkage
	Plastic settlement				External seasonal temperature variations
	Autogeneous shrinkage		Temperature differential due to hydration reaction	Physio-chemical	Corrosion of reinforcement
Frost damage	Premature freezing				Alkali-aggregate reactions
	Scaling, crazing				Cement carbonation

Figure 3. General cracks in RC Structure

6. Concrete Cracks

- ✓ A crack occurs whenever the Tensile Stress on a concrete exceeds the concrete Tensile Strength
- ✓ No engineer designer or builder can guarantee a crack free concrete.
- ✓ A structure design shall consider concrete shrinkage, potential cracking and the restraint on the structures to better control cracking
- ✓ Many cracks can be PREVENTED and those cannot be prevented can be CONTROLLED.
- ✓ CONTROLLED means anticipating cracks in the concrete. I.e.: floor slab – saw cut

6.1 What causes concrete to crack?

- ✓ Restrained free movement
- ✓ Thermal contraction and expansion
- ✓ Uncontrolled drying shrinkage
- ✓ Plastic shrinkage
- ✓ Plastic settlement
- ✓ Subgrade settlement
- ✓ Applied loads
- ✓ Improper formwork removal period

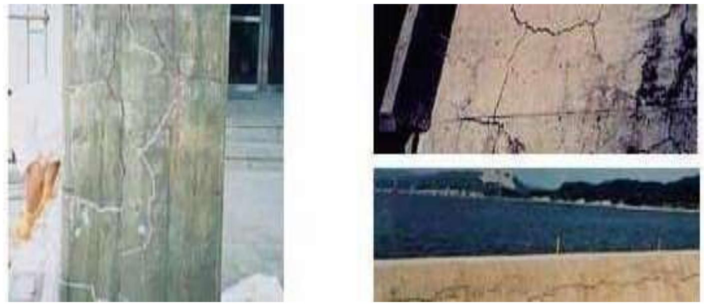
Restrained from free movement

Drying shrinkage crack

6.2 Harden Concrete Cracks

- ✓ The most common factors that contribute to cracks in hardened concrete is drying shrinkage cracking and compressive strength failure due to inadequate design, inefficient concrete cover leading to corrosion of the steel reinforcement
- ✓ The cracks in hardened concrete may be intended, such as construction joints; or not intended, such as irregular cracks from external or internal forces being applied beyond concrete's tensile strength
- ✓ Cracking is natural and does not necessarily indicate a problem
- ✓ Cracks that occur after hardening usually are the results of drying shrinkage, thermal contraction, or sub-grade settlement.
- ✓ Cracks can also be caused by, Alkali-silica reactivity, Sulfate attack and Corrosion of Reinforcement
- ✓ During the initial stage, the cracks usually do not penetrate across the structure thickness. However, after repeated cycles of environmental changes, the pre-existing cracks will extend in its width and depth and may eventually penetrate across the structure thickness and cause unwanted defects such as leakages
- ✓ Thermal cracks occurred when there is excessive temperature differential between the surface and core section of the structural member. The temperature differential will lead to tensile stress formation between the section and eventually lead to cracking when the tensile stress exceeds the tensile strength of the hardened concrete

Corrosion of reinforcement



Alkali Silica Reactivity

Corrosion of embedded steel due to chloride attack

Lack of concrete cover – Cracks occur along the steel bar

6.3 Preventions:

- ✓ Begin cutting sawn joints as soon as concrete will not ravel - use Soft-Cut saw when possible
- ✓ Provide isolate joints to the walls, columns, footings, pipes, etc. so that concrete is not locked in place
- ✓ Use professional steel fixing techniques and spacing to ensure concrete cover is maintained
- ✓ Provide sufficient curing to minimize loss of moisture
- ✓ Provide expansion and contraction joints 1/4 to 1/5 the depth of the slab
- ✓ Concrete needs to move without being restrained
- ✓ Provide properly consolidated sub-grade and drainage systems
- ✓ Minimize the difference in temperatures and humidity between two surfaces of a member
- ✓ Use quality aggregates with minimal ASR potential
- ✓ Use proper mix proportions containing minimum water

7. Plastic Shrinkage Crack

- ✓ Occur when newly placed concrete is subjected to severe drying where the evaporation rate is faster than the bleed water being generated from the fresh concrete.
- ✓ The cracks appear on the surface randomly and seldom penetrate the full depth of slab

7.1 Likely Causes:

- ✓ Rapid loss of moisture from the surface of plastic concrete when rate of moisture loss (evaporation rate) exceeds the rate of the bleed water rise
- ✓ High evaporation rate is caused by:

  Low relative humidity
  High wind velocity
  High fresh concrete temperature

- ✓ Concrete with low bleeding potential and high placement temperature
- ✓ Site workmanship e.g., improper curing, excessive water addition on-site

7.2 Preventions:

- ✓ Retrowel the cracks while concrete still in plastic stage by using wooden trowel or power float machine
- ✓ weather Reduce fresh concrete temperature
- ✓ Protect concrete with temporary coverings during any appreciable delay between placement and finishing
- ✓ Commence curing as soon as finishing work is done by moist curing, plastic sheet covering, curing compound application, wet burlap etc.

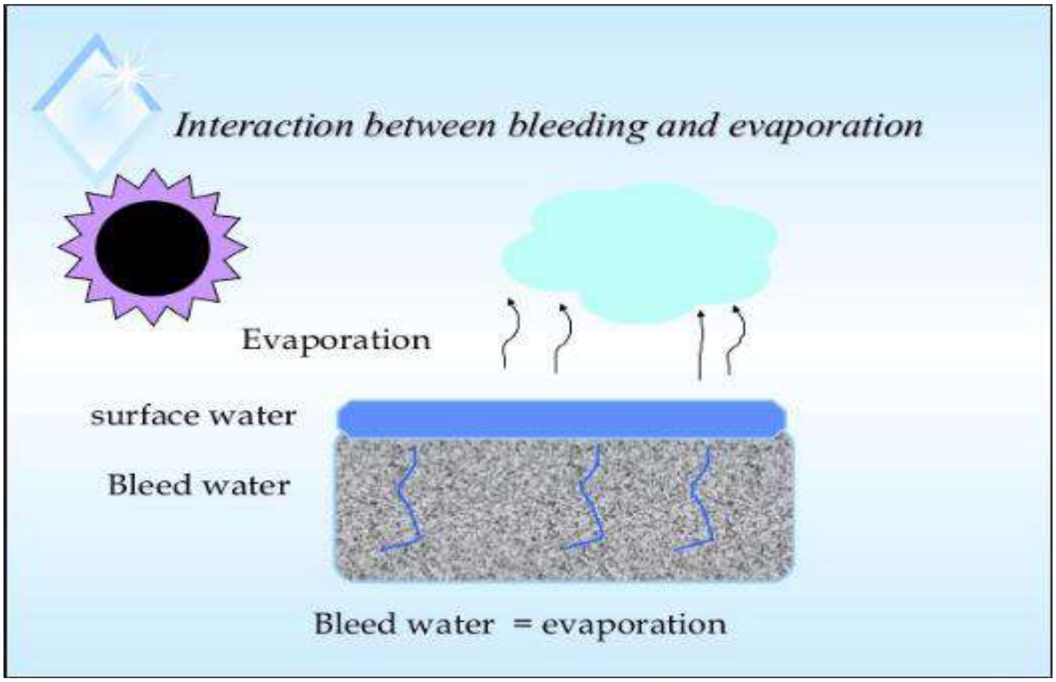


Figure 4. Interaction between rate of concrete bleeding vs rate of bleed water evaporation

8. Plastic Settlement Crack

- ✓ Cracks that formed due to locally restrained plastic concrete by rebar, previous concrete placement or formwork.
- ✓ Concrete has tendency to consolidate after initial placement, vibration & finishing.
- ✓ Occurred adjacent to the restraining element or changes in concrete section.
- ✓ Can be quite wide on surface (up to 3mm), but tends to taper in width.

Likely causes:

- ✓ High bleed characteristic mix (high slump, insufficient cement content, coarse aggregate grading etc.).
- ✓ Insufficient vibration or leaking of formwork.
- ✓ Insufficient concrete cover.
- ✓ Differential settlement.

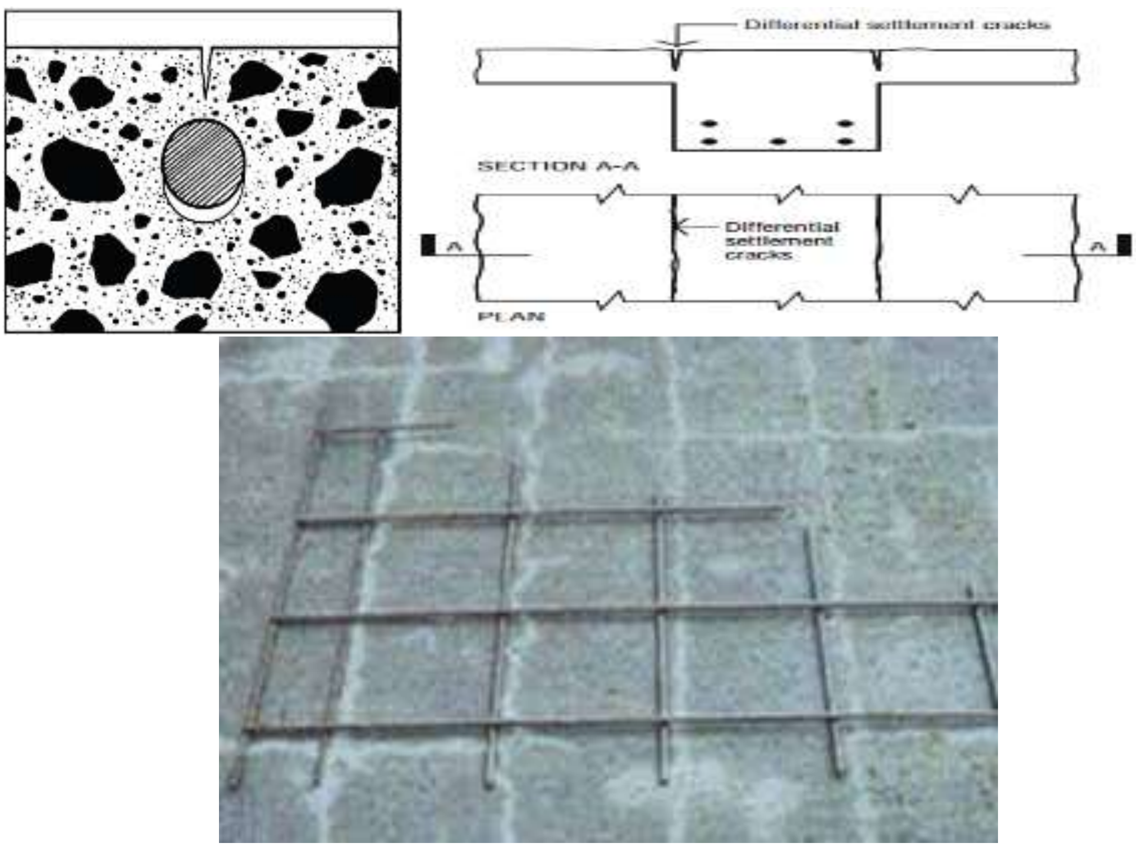
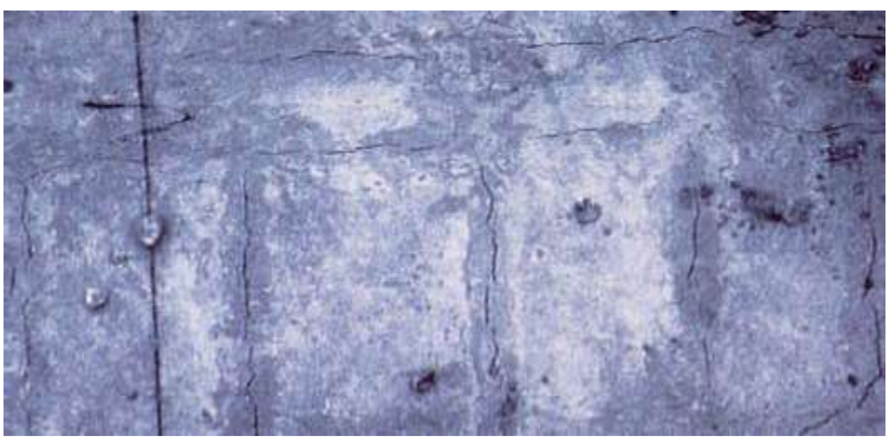


Figure 5. Typical plastic settlement crack

8.1 Prevention of Plastic Settlement Crack

- Increase ratio of concrete cover to reinforcing bar diameter.
  - ✓ Use smaller reinforcement bars but more bars
  - ✓ Adopt the technique re-vibration – The re-vibration should not be applied too soon as a second phase of bleeding can still cause settlement cracks. The correct time can easily be determined by simple site trials. It will be the latest time that a vibrating poker can be inserted into concrete and removed without leaving a significant trace.
  - ✓ It is essential that such re-vibration extends below the top layer of reinforcement
  - ✓ Research by Vollick demonstrates that re-vibration improves the properties of concrete. I.e.: compressive strength
  - ✓ Fiber will reduce the amount of bleed and settlement and will increase the resistance of the concrete to both types of plastic cracks.
  - ✓ Air- entraining admixture also significantly reduce bleeding and can be most effective way of reducing bleeding and settlement
- Control of concrete supply quality (slump, mix homogeneity, grading of aggregates).
- Increase ratio of concrete cover to reinforcing bar diameter.
- Ensure full compaction.
- Provision of time interval between placement of concrete in column/deep beams and concrete placement in slabs and beams.



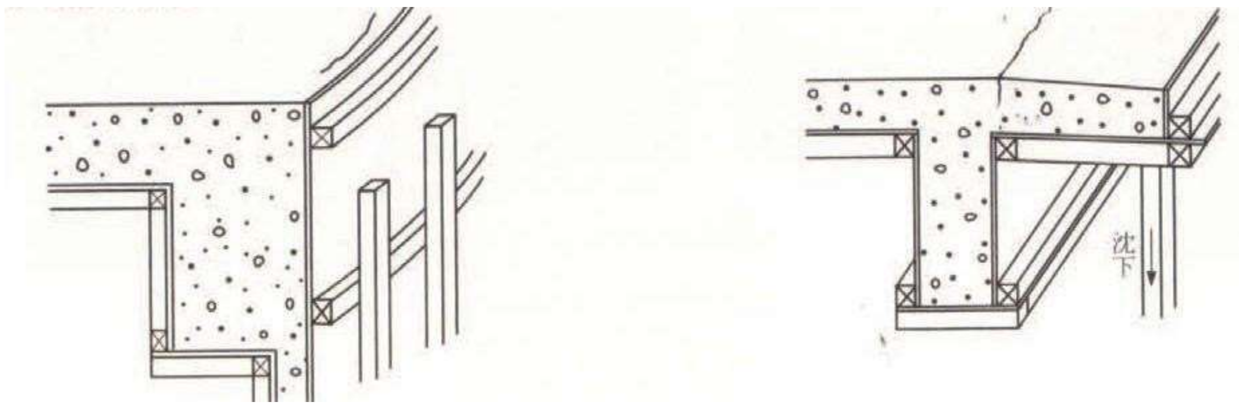
9. Differential Settlement Crack

✓ Cracks occur when there is change in the depth of a section, such as a thick beam and a thinner slab junction

✓ **To reduce the risk of cracking**

- ✓ When concreting, fill up the deep section first to the underside of the thin section
- ✓ Leave the formwork long enough until the concrete has gain sufficient strength to support self-weight

9.1 Deformation of formwork and settlement of support



- ✓ Deformation of formwork can be due to prolonged period of time that the formwork exposes to constant tropical climate changes especially when using steel/aluminum system formwork
- ✓ Not enough probes to support the form works
- ✓ The bolt and nut are not tightening properly

9.2 The supports are sitting on soft ground and cause uneven loading and subsequent formwork settlement issue

9.3 Preventive

- ✓ Care must be taken especially when using recycled formworks
- ✓ Ensure sufficient probes according to the engineering design to support the designed dead load
- ✓ Increase supervision and inspection during installation of the support probes

10 Plastic Movement Cracks

- ✓ Cracks through the depth of concrete before concrete achieved final set

10.1 Likely causes:

- ✓ Disturbance of the freshly casted concrete before it is set
- ✓ Soft sub-grade, movement of forms, tension on re-bars and dowels
- ✓ The bolt and nut of the supports are not tightening properly
- ✓ External factors e.g., piling work in the vicinity of concreting work or unintended impact load on the freshly casted concrete structure

10.2 Preventions:

- ✓ Prevent formwork movement before concrete attain sufficient strength for demolding
- ✓ Reinforcing bars and mesh should not be in tension prior to concrete placement
- ✓ Ensure all the supports are properly installed and tighten according to the design requirement to support the load
- ✓ Avoid heavy machinery movement during early stage of the concreting

11. Concrete False Set

- ✓ Rapid stiffening of concrete shortly after mixing (1-5 minutes after mixing)
- ✓ It's often can be eliminated by continuously mixing or reworking of the concrete to regain its workability

11.1 Likely causes:

- ✓ Recycle water being used where there is very high concentration of cementitious materials in the water caused by poor quality procedures or the wash out pits at the batch plant being poorly designed
- ✓ Excessively high temperature of cement during grinding that resulted in partially dehydrated gypsum and when water is added during concrete mixing, the gypsum reacts and stiffen rapidly can cause false set
  - Note: False set is an erratic condition that doesn't occur consistently in cement from a given source

11.2 Preventions:

- ✓ Additional mixing or remixing of the false set concrete without addition of water. Once concrete regain workability, the hydration will proceed as per normal and concrete will set and gain strength accordingly

NOTE: Frequently when false set is observed in the field, the first reaction is to add additional water. This practice is unnecessary and undesirable since it increases the w/c ratio and reduces the quality of the concrete

12. Concrete Flash Set

- ✓ Rapid stiffening of concrete shortly after mixing, similar with false set phenomena
- ✓ Stiffening always accompanied with heat evolution due to rapid cement hydration reaction
- ✓ Difference with false set is once stiffened, concrete would not be able to regain its plasticity even by reworking or remixing the fresh concrete

12.1 Likely causes:

- ✓ Insufficient or absence of calcium sulfate (gypsum) addition during the clinkering process

12.2 Preventions:

- ✓ At cement plant level, ensure correct amount of gypsum/anhydrite is being added during the clinkering process.
- ✓ At concrete batching plant level, perform periodical quality checking on the incoming OPC to prevent flash set

12 Concrete Delay Setting

- ✓ Delay in normal setting time of fresh concrete

12.1 Likely causes:

- ✓ Placement of concrete during raining or cold weather
- ✓ Organic matter contamination of the materials generally occurs in the mining sand
- ✓ Excessive water addition during batching or on-site
- ✓ Material/ equipment contaminations
- ✓ excessive weighing of supplementary cementitious material
- ✓ Overdose of set retarding admixtures
- ✓ Cement containing excessive or highly soluble SO3
- ✓ Admixtures sludge/settlement in the storage tank
- ✓ Use of contaminated recycle water

12.2 Preventions:

- ✓ Avoid overly wet mixes
- ✓ Ensure incoming raw materials QC eg aggregate, sand, cement and chemical admixtures
- ✓ Ensure chemical admixture weighing is within tolerance especial set retarding admixture
- ✓ Periodic cleaning the admixture storage tank
- ✓ Adjust set retarding admixture accordingly when using supplementary cementitious materials
- ✓ Ensure the recycled or boring water used is tested and comply with the standard specification

13 Cold Joints

- ✓ The undesirable joint or plane of weakness that forms when the first concrete placed reaches a point of set that prevents subsequent concrete from intermixing with the first batch of casted concrete

13.1 Likely Causes:

- ✓ Delays in placing subsequent layers of concrete on underlying or adjacent layers
- ✓ May occur during emergencies such as rainstorms or delivery delay
- ✓ Poor consolidation and/or vibration
- ✓ Note: Cold joints do not often cause structural failures, but disintegration seems to center about the weak planes

13.2 Preventions:

- ✓ Place vertical elements in depths so that subsequent placements can be consolidated into the preceding layer
- ✓ Start placing concrete at corners and work toward the center
- ✓ When placing slabs, batches should be placed against and on the preceding ones, not dumped into individual piles
- ✓ If slab is on a slope, start placing on lower end and work toward top
- ✓ In hot weather or during mass concreting, use additional retarder dosage to increase setting time

14 Crazing Cracks

- ✓ Network of fine random cracks on surface of concrete caused by shrinkage of surface layer.
- ✓ Rarely not more than 3mm deep and 40mm across.
- ✓ Developed during early age (one day after placement or end of first week) Often not visible until the surface is wetted and begins to dry out.
- ✓ Do not affect structural integrity or durability performance.

14.1 Likely causes:

- ✓ Excessive finishing work on concrete surface or sprinkling of cement powder on concrete surface during finishing work
- ✓ Excessive bleed water or mortar on freshly casted concrete
- ✓ Rapid surface drying due to heat, dry wind, low humidity etc.
- ✓ Rapid loss of water produces tensile stresses within the outer layer of which are relievedby random cracking of the paste
- ✓ Premature finishing prior to dissipation of bleed water

14.2 Preventions:

- ✓ Protect fresh concrete from rapid drying prior to finish operations
- ✓ Delay finish steel troweling until bleed water has dissipated or concrete is too stiff for troweling operations
- ✓ Avoid overly wet concrete mixes and prevent any site practices that will lead to excessive concrete bleeding
- ✓ Curing to be commenced as soon as finishing work is done

15 Concrete Dusting

- ✓ Fine, powdery material that easily rubs off under any kind of traffic from the hardened concrete surface.
- ✓ Resulted from thin, weak layer of laitance which composed of water, cement and fine particles.

15.1 Likely causes:

- ✓ Spreading dry cement powder over the surface to accelerate finishing work on concrete slab
- ✓ Use of excessively wet mixes causing concrete bleeding and segregation
- ✓ Uncontrolled water addition on-site or casting during raining
- ✓ Gap graded or angular sands permit passage of water to surface and subsequent concrete bleeding
- ✓ Lack of proper curing
- ✓ Lean concrete mix (inadequate cement content)
- ✓ Presence of impurities and excessive silt and clay content in aggregate and sand

15.2 Correction:

- ✓ Grind off the thin layer of laitance to expose the solid concrete underneath
- ✓ Sand blast, shot blast or use high pressure washer to remove the weak surface area
- ✓ Application of surface hardener e.g., Sodium silicate (waterglass) or metallic zinc or magnesium fluosilicate (improve wearability and reduce concrete surface dusting.
- ✓ This treatment will not convert a basically bad concrete slab into a good one, however, it will improve wear-ability and dusting of surface

15.3 Preventions:

- ✓ Never sprinkle or trowel dry cement into the surface of plastic concrete to absorb bleed water
- ✓ Do not perform any finishing operation before bleed water evaporate
- ✓ Do not place concrete directly on polyethylene or non-absorptive sub-grade
- ✓ Air entrained concrete exhibits less bleeding and therefore less laitance on surface than non-air entrained concrete

16. Bug-holes – Air Void

- ✓ Small pits, bubbles or voids appearing in formed concrete surfaces
- ✓ Many voids are usually exposed by breaking thin skin of dried cement paste covering them

16.1 Likely causes:

- ✓ Inadequate consolidation or vibration causing entrapped air
- ✓ An excess amount of entrapped air due to a high percentage of fines materials especially in sand (silt and clay)
- ✓ Small concentrations of free water on vertical or sloping form surfaces
- ✓ Bad quality form oils that do not permit smooth release of concrete from forms
- ✓ Premature finishing when concrete bleed water hasn't evaporated completely

16.2 Preventions:

- ✓ Place concrete in shallow layers; vibrate each layer
- ✓ When placing against vertical surfaces, vibrate more fully
- ✓ Use external vibrator
- ✓ Proper finishing techniques and timing during and between finishing operations (Flat floating and flat troweling are often recommended)
- ✓ Avoid placing a slab directly on polyethylene film or other vapor barriers
- ✓ Adjust mix proportions to reduce excessive entrapped air by reducing W/C ratio

16.3 Repair:

- ✓ Perform patching work with cement / sand mortar soon after the forms are stripped.
- ✓ Moisten surface and apply mortar with piece of burlap (sacking) or rubber float
- ✓ Mix of 1 part cement to 2 parts sand passing #16 sieve is traditional method
- ✓ Apply adequate curing to repaired surface of concrete

17. Color Variation on Concrete Surface

- ✓ Visual color variations and non-uniformity in the surface texture of concrete

17.1 Likely causes:

- ✓ Premature finishing by adding dry cement to surface
- ✓ Discontinuity in steel-troweling operations resulting in varying degree of surface densification
- ✓ Non-uniform of curing materials such as gunny sack
- ✓ Non-uniform application of mold oils
- ✓ Poor quality of formwork
- ✓ Different OP source being used in the same casting
- ✓ Changing aggregates source in consecutive batches
- ✓ Wide variations in w/c ratio

17.2 Preventions:

- ✓ Avoid use of dry cement on surface to expedite finish operations
- ✓ Ensure uniformity of placing, finishing and curing
- ✓ Provide adequate and uniform curing to exposed surfaces of concrete
- ✓ Use of suitable formwork
- ✓ Avoid changes in materials sources and mix proportions during the same casting day

18 Honeycombing

- ✓ Surface defect of “formed” concrete, characterized by areas of exposed coarse aggregate and insufficient cement paste and mortar
- ✓ Hollow spaces and cavities left in concrete mass on surface or inside the concrete mass where the plastic concrete could not reach

18.1 Likely causes:

- ✓ Insufficient or over-compaction of concrete within forms
- ✓ Severe loss of paste through form joints due to concrete segregation
- ✓ Highly congested reinforcement, narrow section, restricted access for vibration Excessive or inappropriate aggregate size
- ✓ Excessive free fall without chute
- ✓ Segregation due to horizontal movement
- ✓ Reinforcement narrow spacing/ no spacers
- ✓ Vibrator – insufficient length to reach into the concrete
- ✓ Concrete discharge vertically from excessive heights or through rebar
- ✓ Using a vibrator to move concrete in forms
- ✓ Excessive vibration particularly in very wet mixes
- ✓ Segregation due to unsuitable mix proportions or method of handling
- ✓ Low workability of concrete mix

Loss of cement paste through form joints

Excessive height

18.2 Preventions

- ✓ Ensure adhere to proper concreting procedures to eliminate segregation (Tremie, crane and bucket, chutes, pump, etc.)
- ✓ Use consolidation methods applicable for consistency being used
- ✓ Use square end shovels or a flat “come-along” to move concrete by hand
- ✓ Place batches adjacent to one another, not in individual piles
- ✓ Start slope pours at bottom and move upward
- ✓ Use sponge between form joints to prevent loss of cement paste
- ✓ Use less vibration in high slump mixes
- ✓ Use water tight, adequately supported forms
- ✓ Mix concrete within slump range
- ✓ Use air entrainment to minimize segregation in lean mixes
- ✓ Consolidate concrete with vibration or use SCC
- ✓ Use properly proportioned mix that will not segregate when placed into forms

19 Low in-situ compressive strength

19.1 Likely causes:

- ✓ Uncontrolled water addition during placement of concrete
- ✓ Poor placement and compaction of concrete,
- ✓ Lack of curing.
- ✓ Use overdue concrete (concrete which is more than 2 hours for commercial mix)
- ✓ Concreting while raining
- ✓ Water Ponding at the ground structure such as stump, pile cap
- ✓ Premature formwork and support removal

19.2 Preventions:

- ✓ Prevent any uncontrolled water addition on site for easy placement of concrete
- ✓ Adhere to the placement of concrete procedure
- ✓ Commence curing by means of covering with plastic sheet, gunny sack to prevent moisture loss and direct expose to sun light, wind or rain.
- ✓ Finished the concreting within the limit life span of concrete while still plastic.
- ✓ Do not remove the formwork until sufficient strength has been developed.