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Talks Concrete

Essential knowledge of concrete floors

Eng. Salah Abuobaid, MACI

Founder and CEO
Yibna Contracting

Board member
Jordan Concrete Association

American Concrete Institute

Essential Knowledge of Concrete Floors

Salah Abu Obaid

Essential Knowledge of Concrete Floors

- **What are Concrete Floors?** (Rigid pavements)
- **What are Concrete floors used for?**

  Warehouses

  Industrial institutions

  Car parking lots

  Aprons, ports & harbors

  Cold stores and freezer rooms

  Residential buildings

  Roads


ACI 302.1R-15
Guide to Concrete Floor and Slab Construction
Reported by ACI Committee 302
American Concrete Institute
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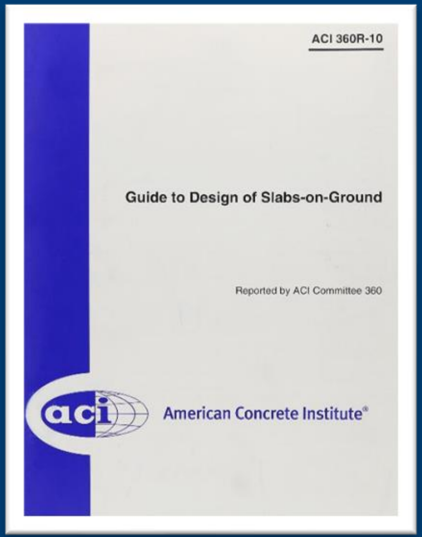

ACI 360R-10
Guide to Design of Slabs-on-Ground
Reported by ACI Committee 360
American Concrete Institute®

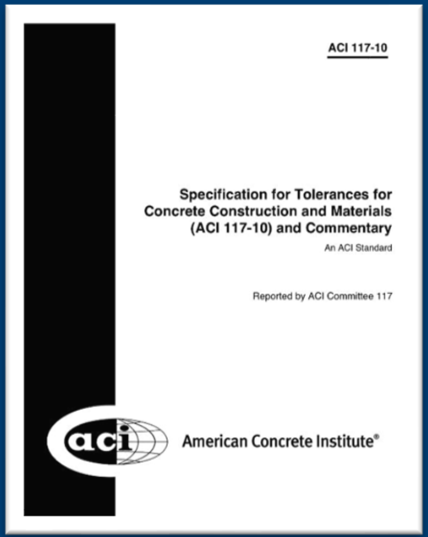
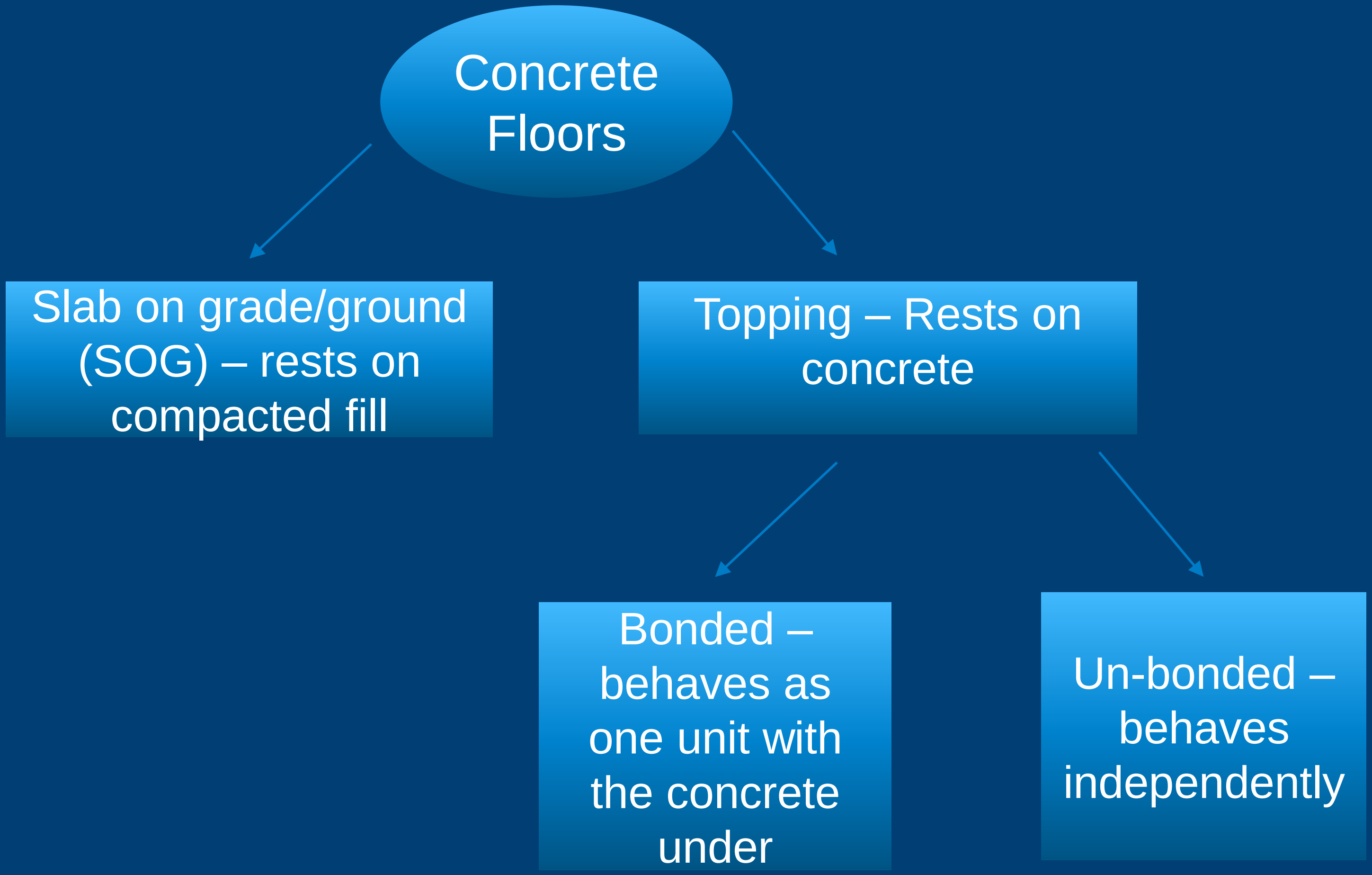

ACI 117-10
Specification for Tolerances for Concrete Construction and Materials (ACI 117-10) and Commentary
An ACI Standard
Reported by ACI Committee 117
American Concrete Institute®

Table 4.1—Classes of floors on the basis of intended use and the recommended final finish technique

Class	Anticipated traffic type	Use	Special considerations	Final finish
1. Exposed	**Exposed surface**—foot traffic	Offices, churches, multiunit residential, decorative	Uniform finish, nonslip aggregate in specific areas, curing Colored mineral aggregate, color pigment or exposed aggregate, stamped or inlaid patterns, artistic joint layout, curing, surface treatment, maintenance	Normal steel-troweled finish, nonslip finish where required Burnishing or polishing to enhance sheen as required
2. Covered	**Covered surface**—foot traffic	Offices, churches, commercial, multiunit residential, institutional with floor coverings	Flat and level slabs suitably dry for applied coverings, curing	Light steel-troweled finish
3. Topping	**Exposed or covered surface**—foot traffic	Unbonded or bonded topping over base slab for commercial or nonindustrial buildings where construction type or schedule dictates	*Base slab*—good uniform level surface tolerance, curing *Unbonded topping*—bondbreaker on base slab, minimum thickness 3 in. (75 mm), reinforced, curing *Bonded topping*—properly sized aggregate, 3/4 in. (19 mm) minimum thickness curing	*Base slab*—troweled finish under unbonded topping; clean, textured surface under bonded topping *Topping*—for exposed surface, normal steel-troweled finish; for covered surface, light steel-troweled finish
4. Institutional/ commercial	**Exposed or covered surface**—foot and light vehicular traffic	Institutional or commercial	Level and flat slab suitable for applied coverings, nonslip aggregate for specific areas, curing; coordinate joints with applied coverings	Normal steel-troweled finish
5. Industrial	**Exposed surface**—industrial vehicular traffic such as pneumatic wheels and moderately soft solid wheels	Industrial floors for manufacturing, processing, and warehousing	Good uniform subgrade, joint layout, joint load transfer, abrasion resistance, curing	Hard steel-troweled finish
6. Heavy industrial	**Exposed surface**—heavy-duty industrial vehicular traffic such as hard wheels and heavy wheel loads	Industrial floors subject to heavy traffic; can be subject to impact loads	Good uniform subgrade, joint layout, joint load transfer required, abrasion resistance, curing	Special metallic or mineral aggregate surface hardener; repeated hard steel-troweling
7. Heavy industrial topping	**Exposed surface**—heavy-duty industrial vehicular traffic such as hard wheels and heavy wheel loads	Bonded two-course floors subject to heavy traffic and impact	*Base slab*—good uniform subgrade, reinforcement, joint layout, level surface, curing *Topping*—composed of well-graded all-mineral or all-metallic aggregate. Minimum thickness 3/4 in. (19 mm) Mineral or metallic aggregate surface hardener applied to high-strength plain topping to toughen, curing	Clean, textured base slab surface suitable for subsequent bonded topping. Special power floats for topping are optional, hard steel-troweled finish
8. Commercial/ industrial Topping	As in Classes 4, 5, or 6	Unbonded topping—on new or old floors where construction sequence or schedule dictates	Bondbreaker on base slab, minimum thickness 4 in. (100 mm), abrasion resistance, curing	As in Classes 4, 5, or 6
9. Critical surface profile	**Exposed surface**—superflat or critical surface tolerance required; special materials-handling vehicles or robotics requiring specific tolerances	Narrow-aisle, high-bay warehouses; television studios, ice rinks, or gymnasiums (ACI 360R)	Varying concrete quality requirements. Special application procedures and strict attention to detail are recommended when shake-on hardeners are used. F_F 50 to F_F 125, superflat floor, curing	Strictly following tecniques as indicated in 8.9

Plus chemical surface treatment such as the Ashford Formula

Note:



Concrete Floors
Slab on grade/ground (SOG) – rests on compacted fill
Topping – Rests on concrete
Bonded – behaves as one unit with the concrete under
Un-bonded – behaves independently

Essential Knowledge of Concrete Floors

- Designers and contractors MUST focus on concrete floors

- Costs 15-20% of entire project

- Most used item in the structure

- **FLOOR MUST SUSTAIN NEW INDUSTRY DEVELOPMENT**
  - Development in racking system and storage methods
  - Development in MHE (mechanical handling equipment) and robotic needs

- **Traits of a good concrete floor**

1. Durability
2. Flatness & Levelness
3. Minimum Amount of cracks
4. Dust proof (Curing & Surface Treatment)

1. DURABILITY

1.1 Right design – ACI 360 1R-10

Input

- Point load from racking
- Distribution load
- Wheel load
- K-value (coefficient of subgrade reaction)

Output

- Minimum thickness
- c – Concrete strength
- Reinforcement
  - Conventional
  - Fibres
    - Synthetic
    - Steel
  - Joint Layout

Cont with durability

1. DURABILITY:

1.2 Concrete Mix Design

- The Concrete Mix is responsible for 50% of the equation
- Concrete for floors is DIFFERENT from concrete for footings, columns & slabs
- Concrete floors have special mix design

- **Properties of Plastic Concrete**

  Workability – Easy to place, compact and strike off

  Finishability – Easy to straight edge, float and trowel

  Bleeding – 1-3%

  Setting time – 3-6 hrs

  Plastic settlement - > 40cm will cause problems in cracks and flatness

Cont with concrete mix design

1. DURABILITY:

1.2 Concrete Mix Design

- **Cement Types:**
  Type 1 (ASTM C150)
  SIM 1 BSEN197-1
  Ordinary Portland cement and NOT PPC

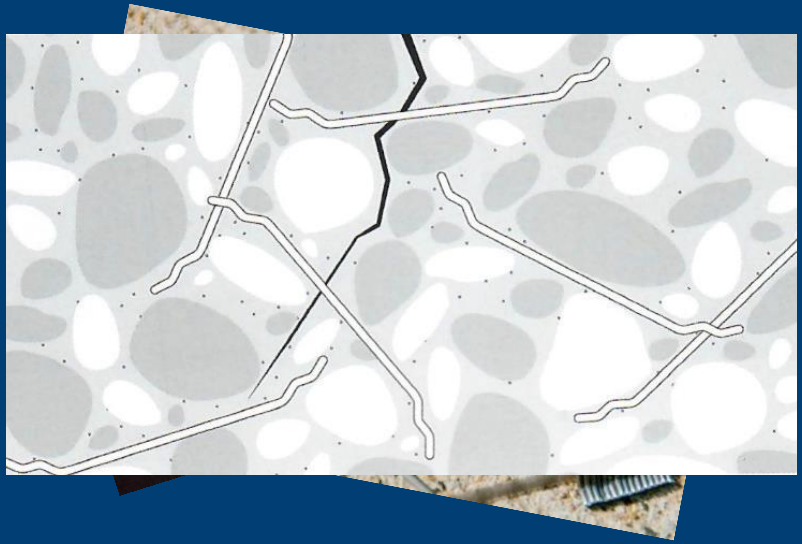
- Cement Content – 325 – 400
  - Larger than 375 makes concrete cohesive
- Admixtures – Type F is preferable.
  - High range water reducer not greater than 2%
- w/c between 0.43-0.55
- Air content not more than 2.5%
- No air entrained admixture can be used

Cont with durability

1. DURABILITY:

1.3 Reinforcement

- No reinforcement for tiling or leveling
- Types of reinforcement
  - Conventional (Rebar or wire mesh)
  - Fibers (Synthetic / Steel)
- Synthetic
  - Micro-Fibers: Plastic shrinkage & settlement cracks
  - Macro-Fibers: Plastic and drying shrinkage cracks
- Steel Fibers: Provides reinforcement
  - Increased strain strength
  - Impact resistance
  - Flexural toughness
  - Fatigue endurance
  - Crack width control



Cont with durability

1. DURABILITY
1.4 Joints in Floors

Types of joints in Concrete Floors

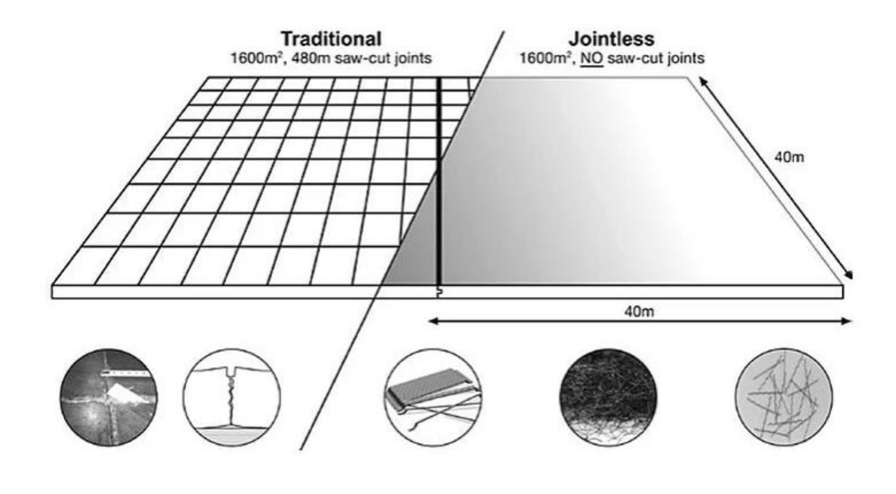
- Construction joints
- Isolation Joints
- Contraction joints

Using steel fibre in floors reduces spacing of contraction joints. Even though we can do jointless floors by increasing the dosage of steel fibres.

Cont with durability

1. DURABILITY
1.5 Evolution in Concrete Floors

- Jointless Floors – Steel fiber
- Seamless Floors – Steel fiber + Rebar
- Sigma Slab: Posttensioned & Steel Fiber



2. FLATNESS & LEVELNESS

What determines a good concrete floor ?

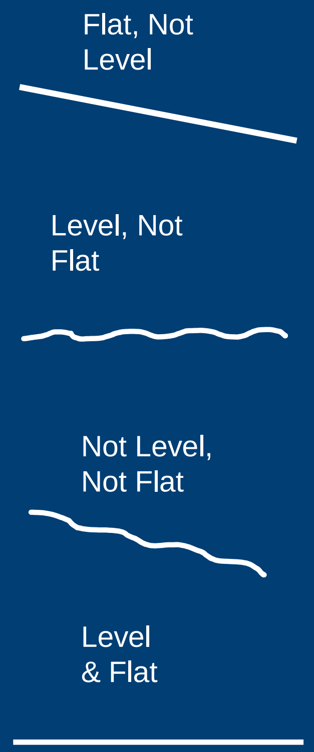
FLATNESS & LEVELNESS

Extremely important

- Flatness – Degree of undulation
- Levelness – Degree of inclination

Why is Flatness and Levelness important?

- Better movement
- Efficient use of space (storing at heights)



Method of concrete floor testing

- Straight edge method
- F-Numbers System

2. FLATNESS & LEVELNESS:

2.1 Methods of testing

Method of concrete floor testing

- Straight edge method
- Advantages
  - Easy to use
  - Availability
  - Does not need training
  - Immediate results
- Disadvantages
  - Not accurate
  - Different testing gives different results
  - Floor may be level but not flat

2. FLATNESS & LEVELNESS:

2.2 Straight Edge Method

ACI 117 -

Table 4.8.6.1—Manual straightedge method

Floor surface classification	Maximum gap 90% compliance Samples not to exceed	Maximum gap 100% compliance Samples not to exceed
Conventional	13 mm	20 mm
Moderately flat	10 mm	16 mm
Flat	6 mm	10 mm
Very flat	N/A	N/A
Super flat	N/A	N/A

2. FLATNESS & LEVELNESS:

2.3 F-Numbers System

What are the F-Numbers?

- The F-Number system is the new American Concrete Institute (#117) and Canadian Standard Association (#23.1) standards for the specification and measurement of concrete floor flatness and levelness.

F_F for flatness and F_L for levelness

- Flatness relates to the bumpiness of the floor
- levelness describes the tilt or pitch of the slab.
- The higher the F-Number, the better that characteristic of the floor.
- F-Numbers are linear

2. FLATNESS & LEVELNESS:

2.3 F-Numbers System

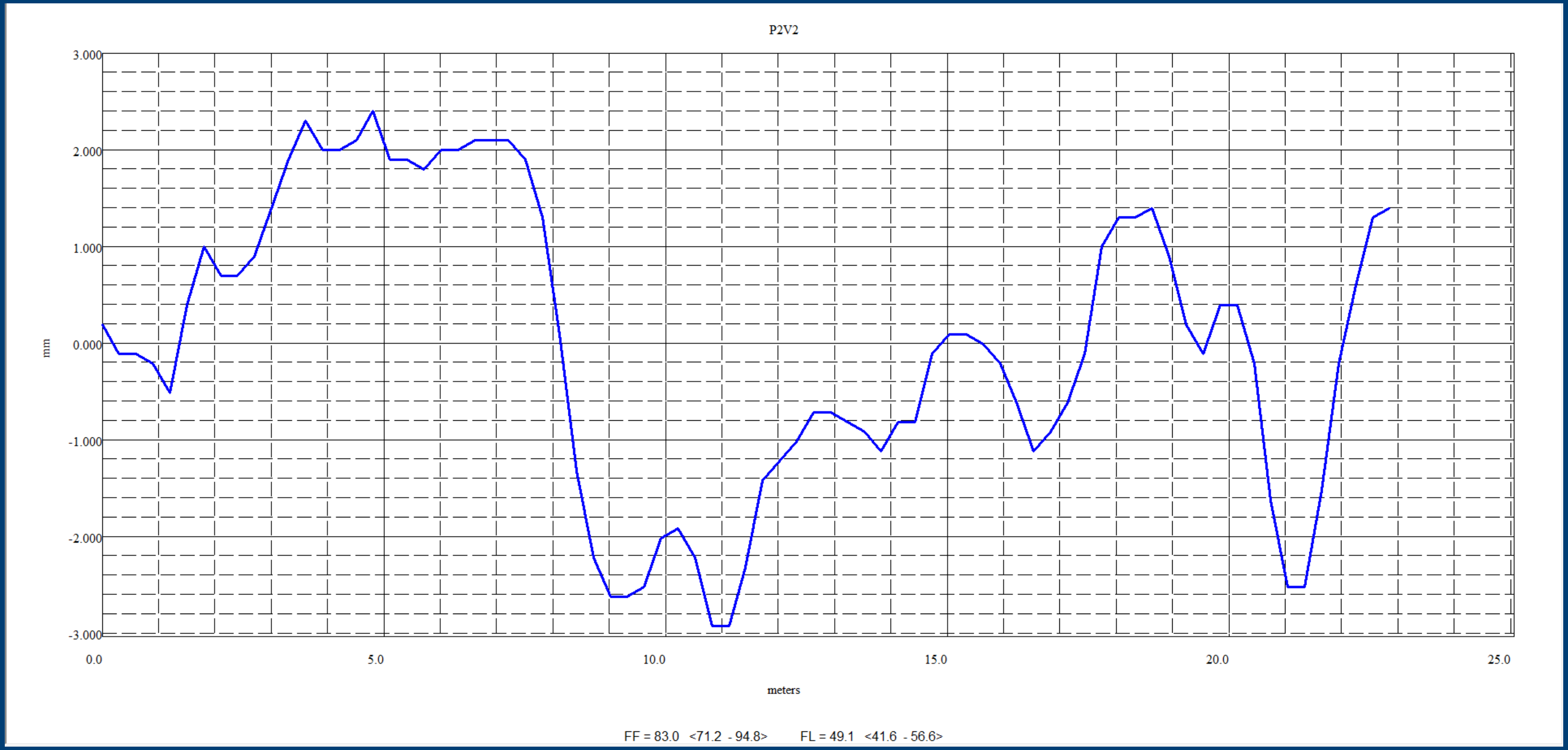
ACI 117 -

Table 4.8.5.1—ASTM E1155M method

Floor surface classification	Specified overall flatness SOF_F	Specified overall levelness SOF_L
Conventional	20	15
Moderately flat	25	20
Flat	35	25
Very flat	45	35
Super flat	60	40

2. FLATNESS & LEVELNESS:

2.3 F-Numbers System



2.4 F-Numbers vs Straight Edge

Table R4.8.4—Methods to evaluate flatness

Floor classification	F_F flatness (SOF_F)	3 m manual straightedge maximum gap, mm
Conventional	20	16 to 7
Moderately flat	25	15 to 6
Flat	35	9 to 4
Very flat	45	7 to 4
Super flat	60	6 to 3

Floor classification	3 m manual straightedge maximum gap, mm	SOF_F range
Conventional	13	17.4 to 27.7
Moderately flat	10	20.3 to 34.9
Flat	6	24.0 to 45.9
Very flat	5	31.7 to 64.3
Super flat	3	37.7 to 109.3

3. Cracks

ACI 302 states the following;

Even with the best floor designs and proper construction, it is unrealistic to expect completely crack and curl free floor. Consequently, every owner should be advised by both the designer and contractor that it is completely normal to expect some amount of cracking and curling on every project, and that such an occurrence does not necessarily reflect adversely on either the adequacy of the floor’s design or the quality of its construction (Ytterberg 1987)

Concrete foundations association (CFA) of north America provides two guarantees with supply of concrete.

1. It will get hard
2. It will crack

3. Cracks

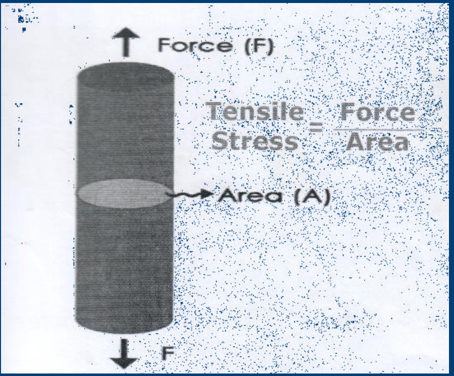
3.1 Why and When

Why Concrete crack?

- Tensile stress inside concrete. T.S = Force/Area

- Tensile strength around 10% of compressive strength.

  C30 – in compressive – tensile strength 3 Mpa



So when?

When tensile stress inside concrete > Tensile strength of concrete

Cracks

What causes cracks?

- Volumetric change
- Thermal stress
- Restrained of slab
- Excessive loading
- Premature loading
- Vibration/movement cracks

Cracks

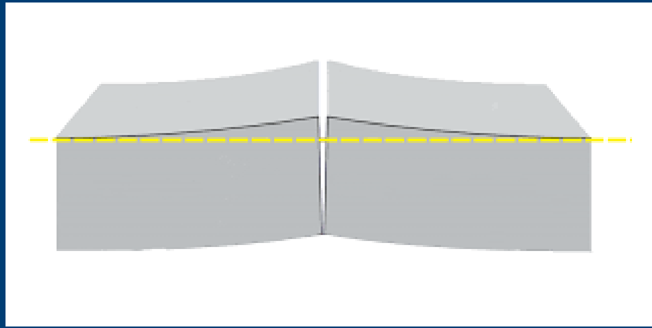
3. Cracks: Types

3.3 Types of cracks

- Plastic
  - Plastic shrinkage cracks
  - Plastic settlement cracks
- Hardened Concrete
  - Drying shrinkage and thermal contraction cracks
  - Differential settlement structural cracks
  - Curling







3. Cracks

3.4 Causes and prevention

- Plastic shrinkage cracks

  Cause – Direct sun and strong wind which will cause hairline cracks on surface

- Prevention
  - Do not pour under direct sun light or in windy weather
  - Make wind breakers
  - Fog spray the surface
  - Cover the concrete with polyethylene sheet as troweling is completed
  - Add microfibres in the concrete

3. Cracks

3.4 Causes and prevention

- Plastic Settlement cracks
  - Cause – No cover above reinforcement
  - Prevention – increase cover and w/c < 0.5
- Drying shrinkage cracks
  - Start to appear after 4-12 months
  - Cause – Excess water in concrete mix – volume change micro cracking develops into full cracking
  - Prevention – Reduce water in concrete mix. Use large aggregates

Rule of Thumb: For every 6m, normal concrete shrinks 3mm

Cracks

3. Cracks

3.5 How to Reduce

How to reduce cracks

- Good mix design
- Polyethylene sheet not less than 250 micron under concrete
- Steel fibre and/or synthetic fibre
- DO NOT pour under direct sun light
- Do not pour in windy weather
- Provide wind breakers and shading
- Do not use water during finishing
- Use all the right joints
- Immediate curing

End -> Dust proof

4.Dust Proof: Curing & Surface treatment

Methods of concrete curing

1. Wet Cure
2. Moist Cure
3. Membrane Cure
4. Chemical Cure

Dust proof

4.Dust Proof: Curing & Surface treatment

1- Wet Curing

- Usually, 3-7 days
- Water is applied to the surface
- Surface is covered by barley then wetting
- Good curing method but it is costly

Cont. Curing

4.Dust Proof: Curing & Surface treatment

2. Moist Curing

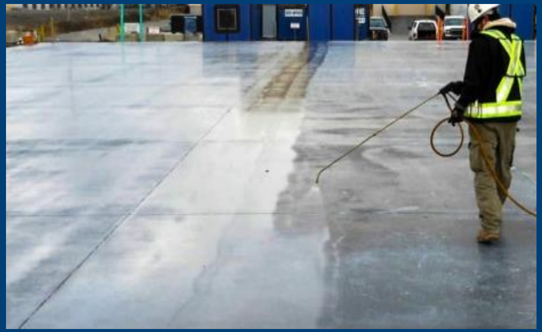
- Usually, 3-7 days or less
- Surface is covered by polyethylene plastic sheet
- Water is trapped on the concrete
- This method might cause discolouring of the surface.

Cont. Curing

4.Dust Proof: Curing & Surface treatment

3. Membrane curing

- Usually wax-resin or acrylic is spread on the surface
- If wax-resin need to be removed later, must scrub with hot water
- Acrylic does not need scrubbing with hot water to be removed later



Cont. Curing

4.Dust Proof: Curing & Surface treatment

4. Chemical cure – alternative to conventional curing (many products mainly silicate)

- Curing compound
- Dust proof
- Sealer
- Densifying the surface increasing abrasion resistance

4.Dust Proof: Curing & Surface treatment

Coatings as surface treatments

- In warehouses, production facilities, and car parking; some floors get coatings to give them properties such as
  - Colour
  - Dust proof
  - Shiny surface
  - Increase in abrasion resistance
  - Easy maintenance

4.Dust Proof: Curing & Surface treatment

Some Types of coatings

- Epoxy
- Polymer-resin coatings
- Polyurethane Coatings

END

Thank you

For the most up-to-date information please visit the American Concrete Institute at:
www.concrete.org