CONSTRUCTION SUPERVISION FOR SITE ENGINEERS

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GOI Funded Post Earthquake Reconstruction of Health Sector Projects in Nepal

Objectives of the Training

1. Understanding Roles & Responsibilities of PMC Site Engineers
2. Deliverables & Expectations
3. Standardize Site Supervision process
4. Quality Control of construction activities
5. Good Practices in construction

Purpose of Site Inspection

- To find out the desired quality of work and materials
- To ensure that work is done as per specifications
- To determine the variation in quality of work done and quality desired
- To have quality control at various stages of construction

Role of PMC Engineer

- To ensure adherence to the approved standards of materials and workmanship
- To ensure corrective action of unacceptable/substandard works
- To resolve issues related to contract documents/ drawings interpretation
- Prevention of errors in construction
- To ensure skillful co-ordination with key stakeholders
- Check site measurement
- Periodic reporting of the progress of the work
- To ensure that recommended safety standards are followed
- Prevention of unfair practices for circumventing contractual obligations

Required Skills of Engineer for Construction Supervision

Observation	Technical Competence	Analytical	Interpersonal Skills
Communication	Negotiating	Problem Solving	

- Should have practical knowledge about the nature of work performed
  - Construction process - method statements
  - Acceptance criteria & tolerances for material & work Material testing
  - Standards & Codes QAP & ITP

- To familiarize with the drawings and specifications of work
- Able to take decisions for non-complying/ defective works
- Reporting observations and actions
- Effective communication with stakeholders

Site Inspection Planning

- Make your plan for inspections at beginning of month
- Submit to project coordinator - Team Leader will approve
- Project manager / coordinator will prepare consolidated site visit schedule
- Send visit schedule to contractor
- Before visit plan items to be checked, do your homework, prioritise items, compliance of past raised items
- Visit the sites as per schedule
- Update project manager / coordinator regularly

Types of Inspection

At Site

-Routine Inspection

labour & machinery
documentation material
construction testing
measurement book progress
safety

-Final Inspection

snag list / punch list

Outside Site

- Factory inspection
- Quarry Visit
- 3rd party lab

Inspection Process

- Documents & Resources required for inspection
- Project Documents review
- Construction Material
- Testing (Including Laboratory)
- Construction Activities
- Measurement
- Progress Update (including manpower & equipment)
- Safety
- Observations & Suggestions
- Daily Report

Inspection Process

Project Documents & Records

Documents
- Contract documents
- Project Specifications
- Relevant codes, Nepal Standards
- Approved Drawings
- Quality Assurance Plan
- Approved Material List

Registers
- Daily Works
- Material
- Site Instruction

(for observation/ suggestions/ site instruction/ non-conformity)

Records
- Concrete Pour Card
- Measurement Book
- 3rd party Test report for steel & cement
- Material test results in approved format
- Concrete cube test Report
- Lab equipment's calibration
- Quality Control Tests Summary

Inspection Process

Daily Works Register Format

DAILY WORKS REGISTER						
S. No.	Location	Activity	Qty.	Remarks	Sign Contractor	Sign PMC Engineer

Inspection Process - Materials

Construction Material

Coarse Aggregate	Fine Aggregate	Cement	Admixture
Reinforcement Steel	Brick	Paint	Structural Steel
Sanitary Items	Electrical Items		

- Material should be from approved Source / Brands / Make
- Check for all new material at site
- Check for Material pending approval
- Refer to testing requirements & acceptance criteria for each item
- Approve / Reject material based on results
- Testing Equipment should be in good condition & calibrated

Inspection Process – Materials Testing

Methodology

- Site to collect and send samples for testing at lab as per frequency
- PMC Engineer to witness sampling & sign on sample tag
- Witness testing at laboratory
- 3rd party testing may be witnessed as per priority
- Check calibration report & status of the equipments
- Review reports & update in inspection report

Inspection Process – Construction Activity

Pre-requisites

- construction plan should be followed
- methodology for construction activities
- checklist items to be understood

Methodology for in process & compiled works

- check layout, levels, alignment & dimensions
- Run the checklist for the construction activity.
- Any non-compliance to be immediately brought to notice
- Check lab test reports for works
- Instruction for non-conformities
- for defective work, analyse condition & decision to repair & reject
- Take feed back from Project Manager / Team Leader
- Update in inspection report

Inspection Process – Quantity Measurement / Certification

Methodology

- Contractor to maintain quantity measurements on MB in approved proforma
- Ensure pages in MB book are numbered & new volume after completion of existing
- To check entry – date entered, dimensions & calculation in MB during visit to site
- Sketches and separate calculation of quantities, if required
- Verify from physical measurement at site
- Report Variations
- Check for pending items for certification in MB during visit

Inspection Process – Quantity Measurement / Certification

Measurement Book Format

PROJECT. . . . . .

CONTRACTOR. . . . . .

M.B.NO..... RA BILL NO.....PAGE NO.....

Sl. No.	Item No. of BOQ	DESCRIPTION	Carried Over to page No. of Abstract	Details of actual measurements				Content Area
				No	L	B	D	

Dtd. Sign of contractor

Dtd. sign. of the Engineer

Inspection Process – Construction Progress

Methodology

- Check mobilization items are completed
- Take target quantity from planning dept. for the entire month at the start of month
- Discuss with contractor for achieving month target
- Check Labour, Machinery & Materials at site
- Check daily entries of quantity done by contractor
- It should match with Quantities in MB
- Review the status of actual v/s planned once in a week
- Action for recovery of delays
- Verify contractor's progress at month end & update to planning dept.

Inspection Process –Safety

Methodology

- Safety is of utmost importance - Respect life
- Look out for any unsafe activity that can lead to accidents at site
- Safety pep talk (10 mins) to contractor staff & labour
- Report and take action on identified safety hazards
- Update safety observations in the Inspection report

Inspection Process – Daily Observation Items

Following items to be considered during site visit

Progress

- factors causing/may lead to delay
- man/material/machine
- suggestion to faster progress

Quality

- Non-conformities/defects in material & work
- deviation in workmanship
- corrective actions
- improvement suggestions

Safety

- safety hazards
- Incidents
- safety improvements

Inspection Process – Daily Report

Daily Report should include

- project manpower & machinery
- project documents & records
- materials received
- laboratory & equipment calibration
- testing done at site
- activities at site
- quantity measurement check
- mobilization & site progress update
- observations & suggestion for improvement

Online App Report

- Use Mobile based App for recording the observations
- Check the pdf report for any errors & correct it if required

Interaction with stakeholders

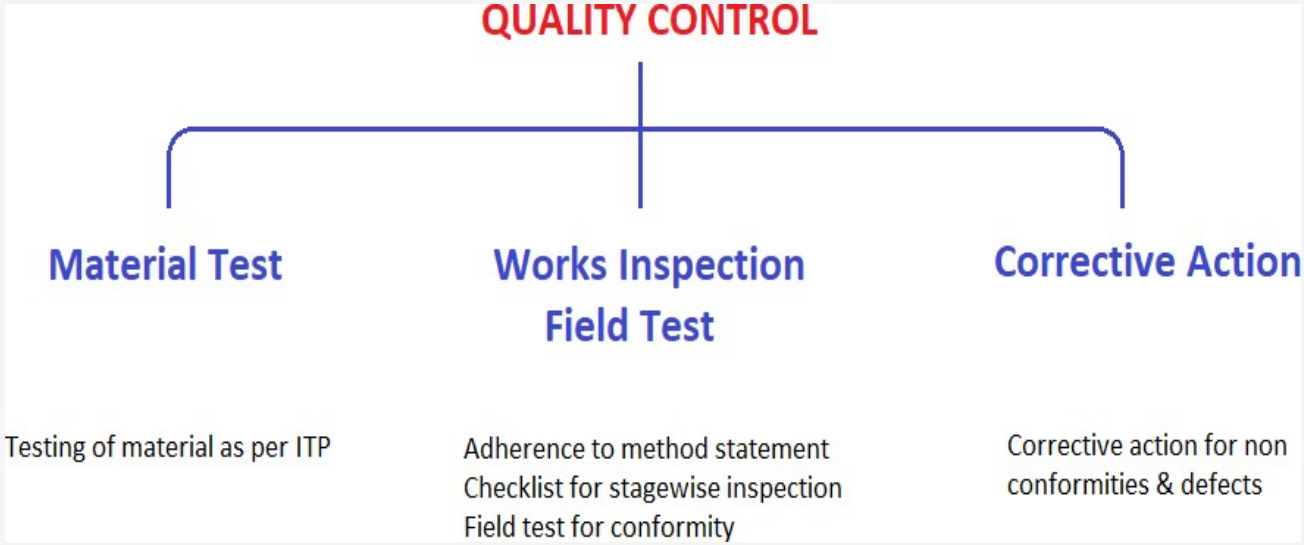
With Contractor

- Interact on a daily basis
- Conduct a weekly meeting at site contractor PM
- Agenda to be followed: progress update, targets, quality, safety, compliance of comments, testing of materials & concrete elements
- Raise other areas of concern
- File MOM for records & review action status

With DLPIU

- Attend weekly / monthly meetings
- Items may be discussed- project progress, hindrances, variations, resources, billing
- Circulate MOM to team for action
- Follow up on action

Quality Control



Quality Control

LABORATORY TEST FOR CONCRETE RAW MATERIALS

COARSE AGGREGATE			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Particle size distribution IS 2386-I	One for each source of supply and one test per day for material received	On receipt at site and before using at site
2	Aggregate Impact Value as per IS-2386 Part-IV		
3	Flakiness IS 2386-Part I		
4	Deleterious Material		
5	Water Absorption		

Note : (1) Use hard, clean and crushed aggregates that should be free from any kind of Material that could result in deterioration of concrete.
(2) Use of 20 mm down aggregate in footing, plinth beam, bond beam, tie column and slab is recommended.

SAND			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Particle Size and shape IS 2386 Part-I	Every new vehicle / trailer received at site	On receipt at site and before using at site
2	Fineness modulus		
3	Deleterious constituents		
4	Bulking test		
5	Silt content IS2386- PartII		

Note : (1) Use river sand for construction. Do not use sea/beach sand as it may contain salts which could result in corrosion of steel.
(2) Use well graded sand and it should be free from mud or any kind of dirt, silt ororganic matter.

Quality Control

BAD GRAVEL
When choosing gravel for mixing concrete, crushed, angular rocks are better. Rounded rocks decrease the available bonding area for concrete particles and lessen overall strength.

GOOD GRAVEL
The best kind of gravel for mixing concrete is crushed stone.

Quality Control

LABORATORY TEST FOR CONCRETE RAW MATERIALS

CEMENT			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Normal consistency	One for each source and when called for by the Engineer Sampling should comply with IS 3535	On receipt of material at site and before using at site. MTC to be produced to the Engineer before use.
2	Fineness		
3	Setting time – Initial/ final		
4	Compressive strength @ 72 hrs, 168 hrs, 672 hrs.		

Note : (1) Do not use cement which is more than 3 months old.
(2) Store cement in a dry and moisture proof building or shelter
(3) It should be covered with plastic sheets to avoid hardening.
(4) Stack cement on a platform, 150-200mm above the floor level.
(5) Do not open the cement bags until required for usage.

WATER			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Alkalinity and acidity as per IS-3025	Once per source of supply and when called for by the Engineer	Before use of water from that source
2	Solids		

Note : (1) Use potable water for mixing and curing, which should be free from organic matter, oils, acids, salts or any other substance that could result in deterioration of concrete or steel.

Quality Control

LABORATORY TEST FOR CONCRETE RAW MATERIALS

REINFORCEMENT STEEL			
S. No.	Type of Test	Frequency of Test	Timing of Test
	3rd Party Testing		
1	Tensile strength, proof stress & Elongation	Once per source of supply and when called for by the Engineer	Before use of steel from that source
2	Bend & Rebend		
3	Chemical Composition		
	On-Site Testing		
1	Review MTC for bars confirming to IS 1786	On receipt of Steel at site	Before using it at site
2	Bars free from rust, mill scales and other impurities		
3	Rolling margin within specified limits for steel		

Note : (1) Use Fe 415 or higher grade of steel as reinforcement.
(2) Do not use corroded, old or bent bars.
(3) Store reinforcement bars on a platform/ wooden runners to prevent corrosion.
(4) Apply cement slurry over rebar to protect corrosion

Quality Control

LABORATORY TEST FOR CONCRETE

CONCRETING			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Compressive strength as per IS-516	One test for 1-5 m3 of concrete	Test samples to be taken while pouring. Testing to be done as specified in contract.
		Two tests for 6-15 m3 of concrete	
		Three tests for 16- 30 m3 of concrete	
		Four tests for 31-50 m3 + one set every 50 m3 of additional concrete work	
2	Slump test per IS-1199	Random checks throughout concreting as directed by the Engineer	Before pouring concrete

Quality Control

LABORATORY TEST FOR BRICKWORKS

BRICKS			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Compressive strength	One test per 50,000 bricks or part thereof	On receipt at site
2	Physical properties		
3	Water absorption test		

Note : (1) Bricks should be watered for about 4 hours before laying.
(2) Masonry should be uniform in size and shape
(3) Minimum 35 kg/cm compressive strength
(4) Minimum 20% water absorption.

MORTAR			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Compressive strength as per IS-2250	One sample for every 2 m3 of mortar subject to a minimum of three samples for a day's work	Test samples to be taken while before applying mortar Testing to be done as specified in contract.
2	Consistency as per IS-2250		

Note : (1) Use mortar in the ratio of 1:3:0.5 (cement: sand: water) for 115 mm thick masonry walls
(2) 1:6:0.5 (cement:sand: water) for 230 mm thick masonry walls.
(3) Adequate quantity of water should be added such that sufficient workability in mortar durings its application.

Quality Control

LABORATORY TEST FOR EARTHWORKS

SOIL FOR BACKFILLING			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Liquid limits and plasticity index	One set of tests for borrow area approval at directed by Engineer	Before use at receipt at site
2	OMC & MDD Test		
3	Deleterious material IS 1498		
4	Grain Size Distribution		
5	Soaked CBR test (optional)		

FIELD TEST FOR BACKFILLING			
S. No.	Type of Test	Frequency of Test	Timing of Test
1	Field density by Core Cutter Method IS 2720-29	One set of tests for each backfilled layer	After laying & compaction

On-Site Quality Monitoring

BRICKS

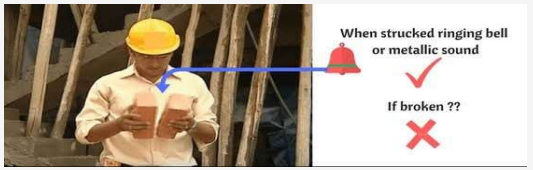
- Take 6 random samples of bricks and calculate its average dry weight. Immerse bricks in water for 24 hrs, then again calculate their average weight. The difference in final average weight and initial average weight indicates the amount of water absorbed by the bricks. It should not exceed 20% of average weight of dry bricks.
- Closely observe bricks for uniformity of their shapes, size and colour. Bricks should be rectangular in shape with sharp edges.
- Put a scratch on the brick surface with finger nail. For brick to be hard enough, no impression or mark should be visible on the surface.
- Gently struck two bricks with each other. A good quality brick will not break and will generate a metallic sound.
- Break a brick and examine its structure. It should be homogeneous, compact and free from holes and lumps.
- Conduct compressive strength tests on randomly selected brick samples. (Refer IS 3495: (Part 1) – 1992)

CEMENT

- Open the bags to check the presence of lumps. Presence of lumps is the indication that setting has started, and thus that cement shall not be suitable.
- Take a pinch of cement and rub it between fingers. It should give a smooth texture, otherwise if it is rough, it indicates that the cement is adulterated with sand.
- Smell a pinch of cement. If it gives an earthy smell, it indicates that cement is adulterated with clay and silt.
- Put a small quantity of cement in a bucket of water. Cement should sink and must not float on water.
- Cement should be uniform in colour. Colour of cement is grey with a light greenish shade.

Over burned/Irregular bricks

Brick Uniformly burned



Checking quality of brick on site

Cement stored in ground above brick soling

Cement stored above wooden plank

Hardened particles

Manufacture date

On-Site Quality Monitoring

SAND

- Take a transparent glass, half filled with water. Add sand, 1/4th volume of glass in water and shake vigorously. After a minute, a distinct layer of settled silt and sand will be noticed. Measure its depth and calculate percent of silt content, which should be limited to 5%.
- Rub a pinch of sand between the fingers. If fingers get stained, it indicates that the sand is adulterated with the earthy matter.
- Add solution of caustic soda in sand to detect the presence of organic impurities. If the colour of solution changes into brown, it indicates the presence of organic impurities.

Adulterated Sand

Clean Sand

Flaky and elongated aggregate

Well graded angular aggregate

REINFORCEMENT

- The bend test should be carried out with bending devices as specified in IS 1599: 1985. Absence of cracks in rebar shall be considered as the evidence that the test piece withstood the bend test.
- The tensile strength test and elongation of steel should be carried out with reference to IS 1608: 2005. Tensile strength obtained from the test should be equal to the strength specified by the manufacturer.
- The pull-out test should be carried out to determine the bond stress in rebar. The rebar specimen should be placed in testing machine such that the bar is pulled axially from the cube. The test procedure should be followed and bond stress should be calculated in accordance with IS 2770 (Part 1): 1967.

Tensile Strength and Bend Test on Reinforcement

On-Site Quality Monitoring

CONCRETE

- Mix cement, sand, coarse aggregate, water and super plasticizer as per the mix design.
- Concrete mix should be consumed within 30 minutes after preparation.
- During casting, concrete should be properly mixed and compacted by mechanical means.
- Exposed surfaces of casted concrete should be properly cured; either by ponding or by covering with wet hessian cloth for a minimum of 7 days.

(For details refer IS 456: 2000, IS 10262: 2009, IS 1199: 1959, IS 2386: 1963)

MASONRY

- Provide 10 mm thick mortar in joints of masonry courses.
- Maximum 1.2 m high brickwork should be carried out in one day.
- Provide 8 mm reinforcement bar in 115 mm masonry walls after every fourth course.
- The joints and edges should be properly formed and excessive mortar from the joints should be neatly removed by a trowel.
- Restrict length/thickness ratio of wall to 20. Otherwise provide pilaster (brick column) to fulfill this requirement.
- Masonry walls should be cured for 7 days.

(For det*ails refer IS 3495: 1992, 1077: 1992, IS 2212: 1991, IS 6042: 1969)*

MORTAR

- Mortar should be prepared using measuring boxes and the mixing of mortar should be done in mortar pan in designed proportions.
- Mix cement and sand properly so that it gives uniform color and workable consistency.
- Fist prepare dry mix of mortar (cement and sand) in adequate quantity and add water in appropriate quantity when required, so that wet mortar mix can be utilized within 30 –45 minutes.
- The mortar used in masonry should not contain excessive water.

(For details refer 2250: 1981 IS, IS 3085: 1965)


Measurement of Ingredients by unstandard container

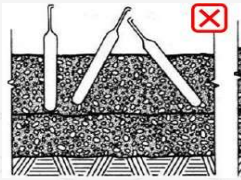

Measurement of Ingredients by standard box

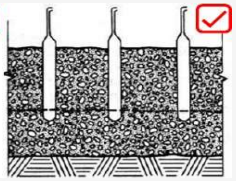

Concrete mixing manually with poor quality


Concrete mixing by machine


Cover not maintained


Proper use of Cover block


Vibrator position inclined and not Penetrated through previous layer


Kept vertically and penetrated through previous layer

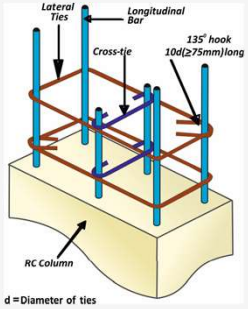
On-Site Quality Monitoring

COLUMN

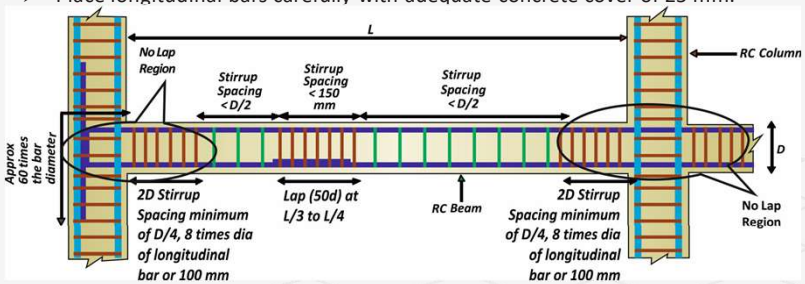
- The reinforcement detailing in columns shall be provided as shown in the figure.
- Place longitudinal bars carefully with adequate concrete cover of 40 mm.
- The laps in longitudinal reinforcement of column shall be spliced in mid-half length and confined with ties at 150 mm spacing. Not more than 50% cross-sectional area of bars shall be lapped at a section.
- The detailing of reinforcement in beam-column joints at end span shall be as shown in the figure.
- Provide cross-ties if parallel legs of lateral ties are spaced at a distance of more than 300 mm c/c.
- Mechanical splicing shall be adopted for bars of diameter larger than 32 mm.

BEAM

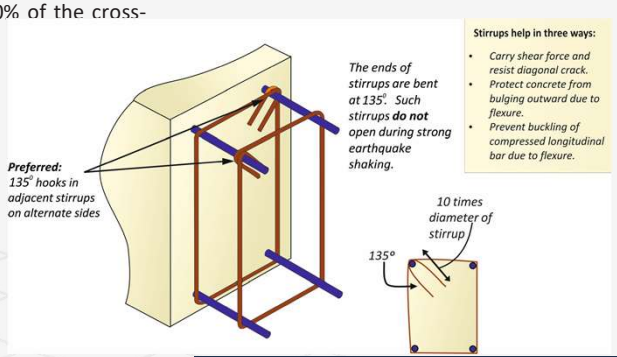
- The reinforcement detailing in beams should be provided as shown in the figure.
- Lap splices should not be provided within a joint. The laps may be provided in L/3 to L/4 region of beam. Lap length should not be less than the development length. Not more than 50% of the cross-sectional area of bars should be spliced at any section.
- Place longitudinal bars carefully with adequate concrete cover of 25 mm.



Cross Tie and 135° Hook in Lateral Ties

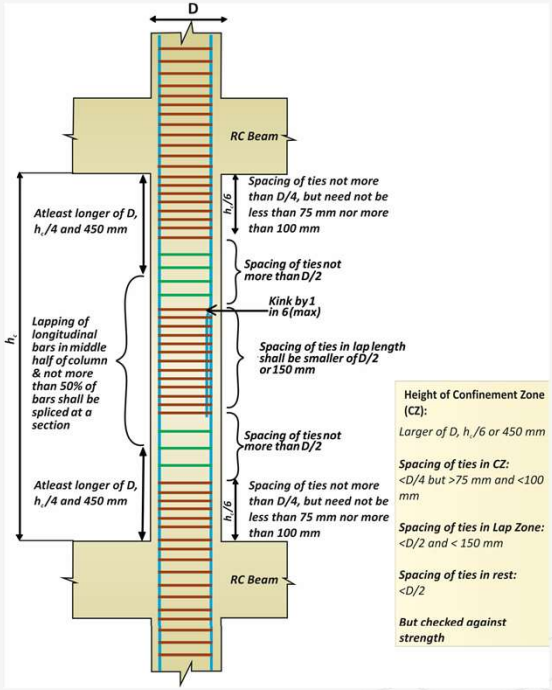


Reinforcement Detailing in RC Beam

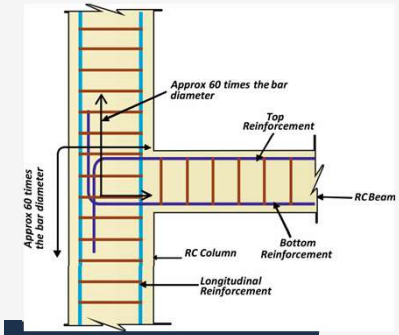


Stirrups detailing in Beams

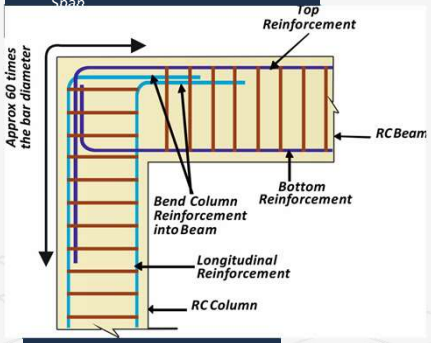
On-Site Quality Monitoring



Reinforcement Detailing in RC Column



At Intermediate Floor End Span



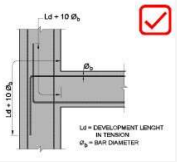
At Roof Floor End Span

At Beam-Column Joint

The case where beam reinforcement passing outside of column reinforcement

Reinforcement of beam confined by column reinforced

Insufficient Development Length



Sufficient Development Length

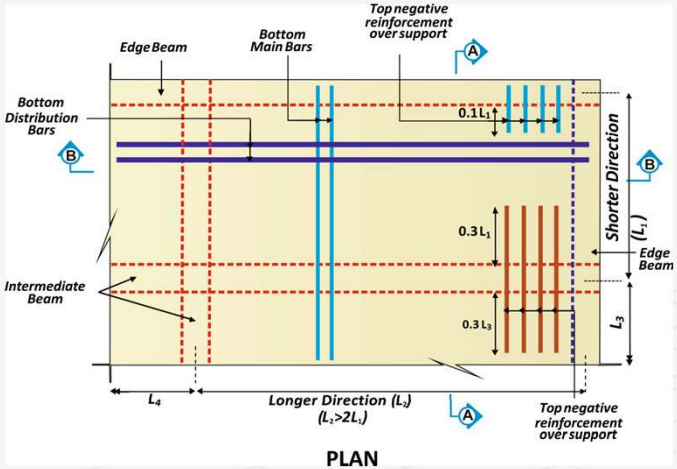
On-Site Quality Monitoring

SLAB

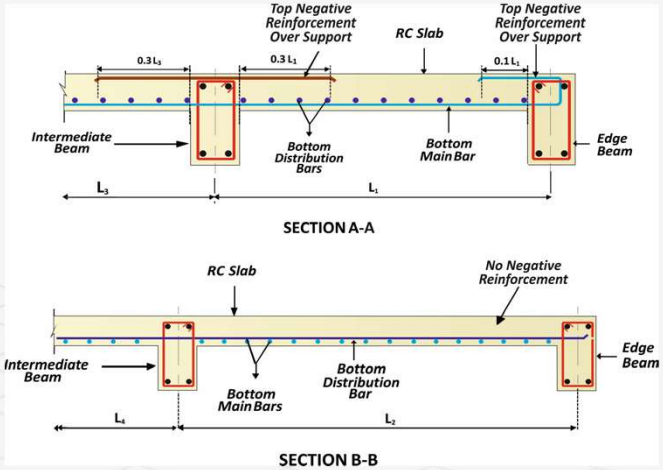
- The reinforcement detailing in slabs shall be provided as shownin the figure below.
- Cranks in slabs are not permitted due to poor performancein seismic shaking.
- Minimum slab thickness shall be 100mm.
- Generally, slab thickness shall be calculatedas shorter spam/28 or 100 mm, whicheveris higher.
- The minimum coverto reinforcement shall be not less than 15 mm, nor less than the diameter of bar.

ONE WAY SLAB

- When ratio of longer span to shorter span of slab is greater than 2.



PLAN

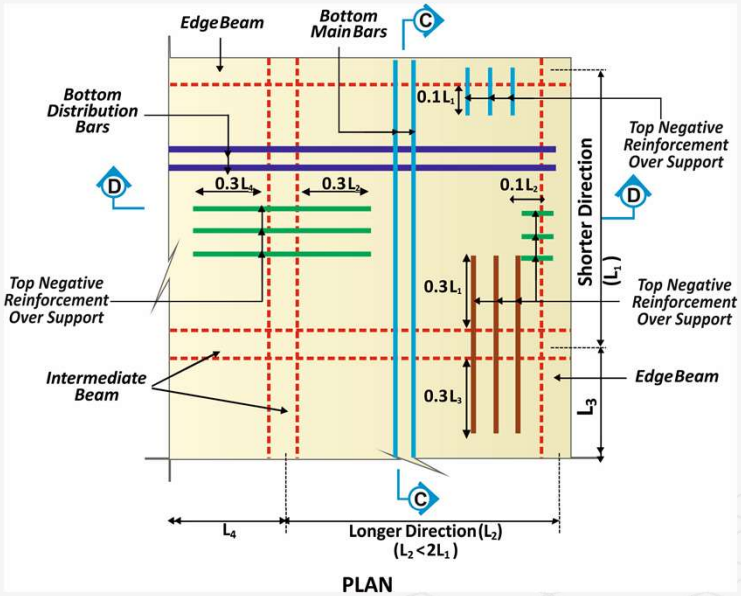


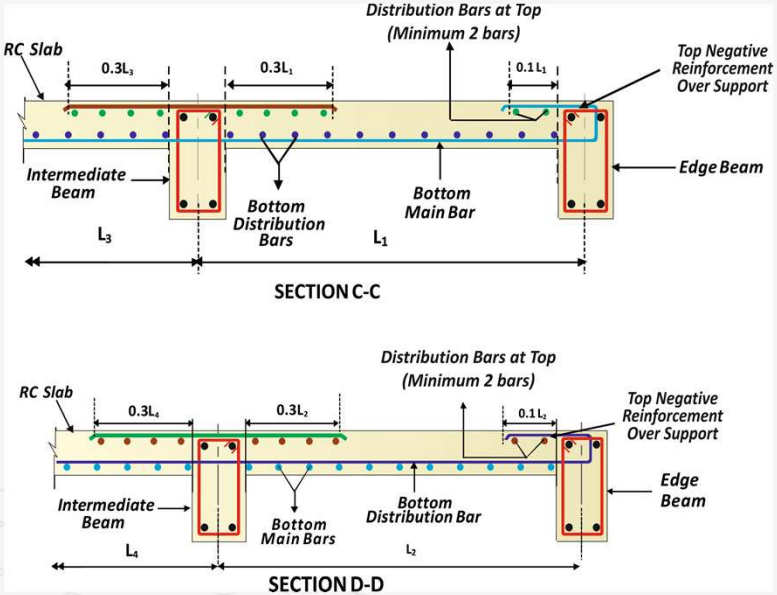
SECTION B-B

On-Site Quality Monitoring

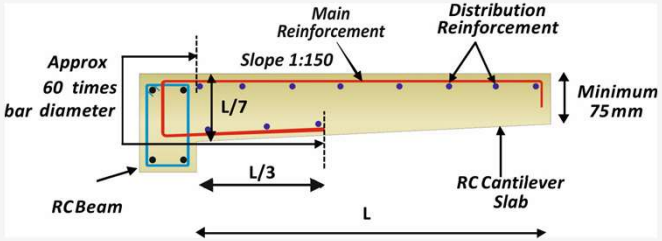
TWO-WAY SLAB

When ratio of longer span to shorter span of slab is less than 2.

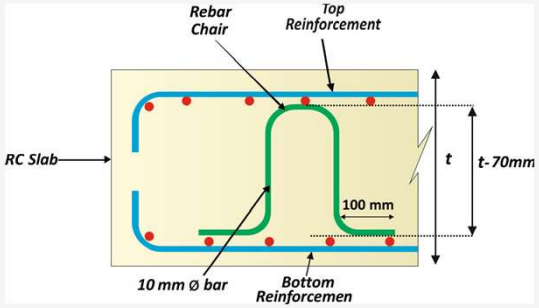




On-Site Quality Monitoring



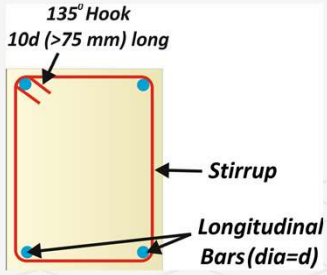
Projected Slab from Beam



Rebar Chair in Slab

STIRRUPS

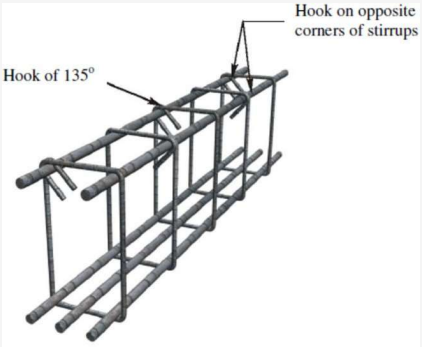
- The reinforcement detailing of stirrups should be provided as shownin the figure.
- Ensure that stirrups are properly tied with binding wires.



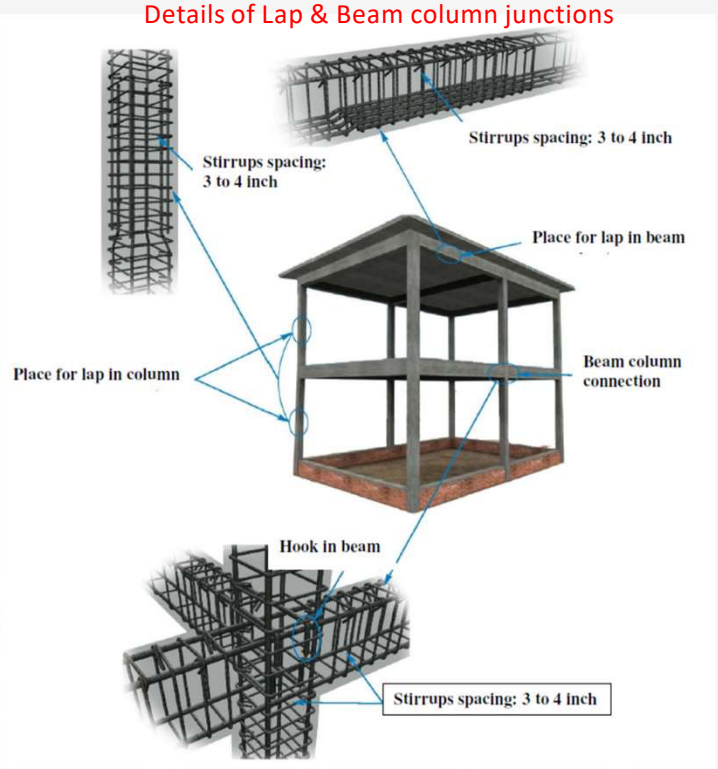
Stirrup Detailing

On-Site Quality Monitoring

Hook on opposite end of stirrups

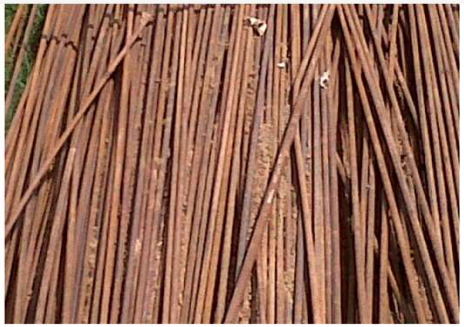


Details of Lap & Beam column junctions

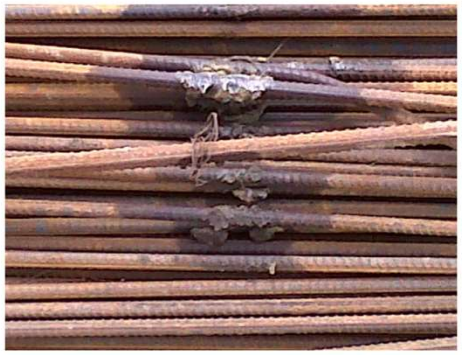


On-Site Quality Monitoring – Reinforcement Stacking

REINFORCEMENT STEEL STOCK YARD



BAD HANDLING OF R/F



BAD HANDLING OF R/F

REINFORCEMENT YARD IN BAD SHAPE

On-Site Quality Monitoring – Cover Blocks

Cover Blocks

Cover blocks are placed to prevent steel rods from getting exposed to atmosphere, and to place and fix the reinforcements as per the design drawings

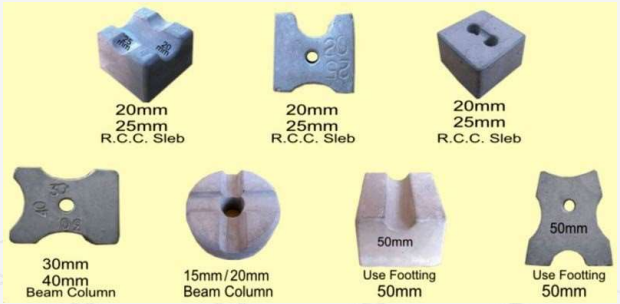
Cover block should have similar strength to the surrounding concrete

Shape of cover blocks – cubical or cylindrical

Common Types of cover blocks – Concrete , PVC

As per IS 456, cover should be :

- 40mm for columns
- 25 mm for columns of minimum dimension of 200 mm or under
- 50 mm for Footing
- 30mm for moderate exposure
- 20mm for mild exposure (15mm if bars of 12mm dia are used)



On-Site Quality Monitoring - Formwork

Conventional Formwork

Commonly provided structural members

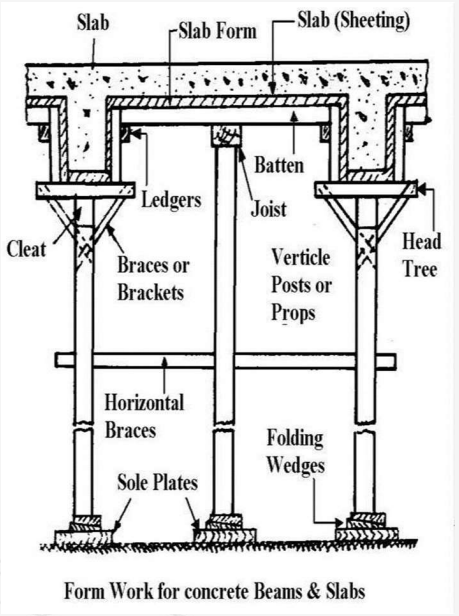
Footing

Column

Stair

On-Site Quality Monitoring - Formwork

Slab & Beam Formwork



Form Work for concrete Beams & Slabs

On-Site Quality Monitoring - Formwork

Requirements of Good Formwork

- It should be strong enough to withstand all types of dead and live loads.
- It should be rigidly constructed and efficiently propped and braced both horizontally and vertically, to retain its shape
- The joints in the formwork should be tight against leakage of cement grout.
- Construction of formwork should permit removal of various parts in desired sequences without damage to the concrete.
- The formwork should be set accurately to the desired line, and levels should have a plane surface.
- The material of the formwork should be of good quality & not warp or get distorted in 1-2 reps

Quality Checks

- Dimension as per drawing
- Proper support, props spacing, struts, bracing
- Supports rest on a firm base.
- No gaps/ holes in sheeting / forms
- Shuttering oil / form release agent applied

On-Site Quality Monitoring – Concreting

Checklist before allowing concrete

- Materials used have been tested & conform to relevant Specifications - Sand, Coarse Aggregate, Cement , Water, Reinforcement Steel
- Structural & Architectural Drawings Correlated
- Treatment of expansion joint, wherever required, is done
- Clean shuttering is used & shuttering oil application is proper
- Line , Level & Plumb of shuttering is OK
- Reinforcement detailing, their placement is as per structural drawings
- Proper gauge binding wire is used and with full cross binding and tightening of reinforcement bars with stirrups
- Required minimum cover to reinforcement is maintained
- Any holding arrangement for MEP services like clamp, angles have been checked and found OK
- Conduits for various MEP services have been checked and found OK
- Sufficient raw material available for concrete quantity

On-Site Quality Monitoring – Concreting

Concrete Batching

- Mix proportion appropriate for the job (either nominal or design) should be used
- Correction of moisture content/water absorption in aggregate should be given and total water content in the mix should be adjusted appropriately
- In case of volume batching bulkage correction factor for fine aggregate should be given
- Slump appropriate for the job should be maintained. Too little of too much slump will spoil a otherwise good concreting job

Precautions

- Avoid manual concrete mixing
- Keep a close watch on the water quantity while mixing
- Minimum mixing time should be 2 minutes
- Use admixtures only if required
- Admixture dosage should be optimized.

Concrete Mixers used in the project

On-Site Quality Monitoring – Concreting

- Concrete produced shall be checked for slump & Adjustment in water addition to be done to maintain slump
- Check for uniform mix and no segregation / bleeding

Placing Conditions	*Degree of Workability*	*Slump* (mm)
(1)	(2)	(3)
Blinding concrete; Shallow sections; Pavements using pavers	Very low	*See* 7.1.1
Mass concrete; Lightly reinforced sections in slabs, beams, walls, columns; Floors; Hand placed pavements; Canal lining; Strip footings	Low	25-75
Heavily reinforced sections in slabs, beams, walls, columns; Slipform work; Pumped concrete	Medium	50-100 75-100
Trench fill; *In-situ* piling	High	100-150
Tremie concrete	Very high	*See* 7.1.2

On-Site Quality Monitoring – Concreting

Cube Casting – Standard Practices

			
Sampling	Cube casting	Finishing	Tagging/marking
			
Demoulding	Shifting to Curing Tank	Testing @ 7&28 days	

On-Site Quality Monitoring – Concrete Placing & Finishing

Concrete Placing

- Walking rails should be provided on slabs before concrete placement so that reinforcement will not get disturbed
- Need to make sure form surfaces and bracing is right before placing concrete
- Need to avoid segregation of materials in concrete
- Wheelbarrows, buggies, chutes, pumps, conveyors, buckets, trucks
- Concrete should be poured from not more than 1 m height

Compaction by vibrator

Concrete Compaction

- Compaction means removing air from concrete
- It will reduce the voids
- Lesser the voids stronger the concrete
- Proper compaction will ensure water tightness
- Compaction by use of needle vibrator is recommended
- Manual compaction to be avoided

To avoid such occurence

On-Site Quality Monitoring – Concrete Placing & Finishing

Finishing

- Finishing – bring surface of concrete to its final position and surface texture Screeding – striking off excess concrete

  Floating – smoothes and compacts concrete imbeds aggregates Troweling – compacts surface

  Brooming – surface texture

Finishing

On-Site Quality Monitoring – Concreting

Checks During Concreting

- Concrete of approved design mix within maximum permissible water-cement ratio is used
- Admixture of approved brand is used
- Technical supervision at batching plant/mixer and at point of concreting done
- Trained Mason available
- Concreting is done when temperature conditions between 4.5 to 38 C
- Concrete is placed within initial setting time of mixing
- Proper compaction with vibrator is done
- Concreting has been done in a lift not exceeding 1.5 m
- Slump tested & Cubes taken as per requirement filled for testing
- Check for formwork displacement
- Check for slurry leakage
- Check for top levels

On-Site Quality Monitoring – Curing

Curing

- All newly placed concrete shall be cured in accordance with specification & standards.
- The most common methods of curing are the following: (1) Water curing (2) Curing Compound
- Water curing has to be done for a period of min 7 days from day of casting

Water Method

Curing Compound

On-Site Quality Monitoring – Formwork Removal

Formwork Removal

- Minimum period before removing formwork is given in table
- Honeycombing if any should be rectified immediately (if accepted for repair)
- Date of casting should be written on the concrete member

Type of Formwork	*Minimum Period Before Striking Formwork*
a) Vertical formwork to columns, walls, beams	16-24 h
b) Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)	3 days
c) Soffit formwork to beams (Props to be refixed immediately after removal of formwork)	7 days
d) Props to slabs:	
1) Spanning up to 4.5 m	7 days
2) Spanning over 4.5 m	14 days
e) Props to beams and arches:	
1) Spanning up to 6 m	14 days
2) Spanning over 6 m	21 days

On-Site Quality Monitoring – Formwork Removal

Checks to be performed after deshuttering

- Shuttering stripped off as per specification, and laitance removed immediately thereafter
- Proper arrangement of curing and curing period maintained as per specifications
- Hacking of RCC surface by proper hacking tool for subsequent plastering / finishing is carried out
- Appearance of Surface defects like honeycombing & bulging

Concreting Defects

Bugholes / Pinholes

Slurry leakage

Concreting Defects

Honeycomb

Severe Honeycomb

Concreting Defects

Cold Joint

Poor surface finish

Concreting Defects

Formwork Deviations

Chip off / Damages to concrete

Concreting Defects

Cracks

Concreting Defects

Possible Causes

- Poor Concrete compaction due to ineffective vibration or Rebar congestion.
- Concrete slurry leakage along the perimeter side forms due to:
- Defective formwork
- Loose or missing supports
- Inadequate concrete vibrator and negligence to vibrate
- Less concrete cover and spacing between the reinforcement
- Inadequate supervision and no hammering the side surface to remove the voids/Bubbles
- forms may not be sufficiently rigid to maintain specified tolerance during concrete pouring

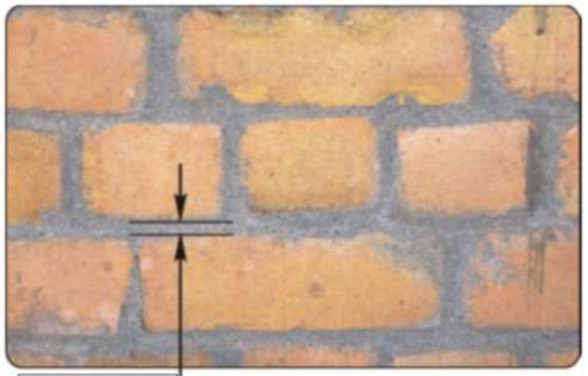
Corrective Action

- Honeycombing and pin holes must be rectified immediate after stripping of sides with approved repairing Material.
- Excessive Honeycombing should be further studied before deciding to dismantle or repair
- Structural cracks to be studied before corrective action

Brickwork

Brick Masonry

- Always use first class bricks for wall masonry.
- Cement sand mortar 1:3 for 115 mm and 1:6 for 230 mm thick walls to be used for masonry work.
- Thickness of mortar between two brick courses should not be more than 10 mm in any case. Thicker the mortar layer, weaker the masonry work would be.
- Soak the bricks in water for 1 to 2 hours before their use. In this way, bricks do not absorb moisture from mortar and the brick mortar adhesiveness increases
- Use of old bricks should be avoided.
- Minimum 7 days curing is required for masonry work. Use drinking water for curing.



Brick Masonry


Soaking of bricks

Quality Checks for Brickwork & Plasterwork

Brickwork

Curing of masonry units.
Distribution of masonry courses as per the height to be achieved for next level.
Mortar mix as specified (1:3 for 115 mm thick walls and 1:6 for 230 mm thick walls).
Joints thickness (not more than 12 mm).
Vertical profile and flatness of wall.
Reinforcement/Dowels in place, as per the specification (8 mm reinforcement bar after every 4th course).
Joints even and racked.
Door/window openings as per drawing.
Lintel beams provided as per drawing.
Block work done in layers not exceeding 1.2 m.
Unwanted particles are removed.
Masonry date marked after end of day's work (for 7 days curing).

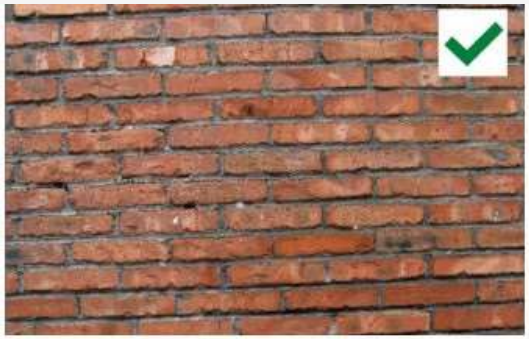
Plasterwork

Double Scaffolding for plastering wall
Wetting masonry surface before plastering
Mortar mix as specified (1:3 for 115 mm thick walls and 1:6 for 230 mm thick walls)
All holes and gaps are properly filled
Under Coat : Plaster to be finished to a true and plumb surface and the surface shall be left rough and furrowed 2 mm deep
Finishing Coat : Check final finish & grooves as per drawing
Finished plaster has even surface and proper degree of smoothness
Check work visually after completion for groove lines, joints, and sharpness of corners
Mark the date after completion to have control over curing. The plaster to be kept wet for a period of 7 days
Cleanliness and unwanted particles cleared away.

Quality Checks for Brickwork & Plasterwork

BAD MASONRY

Bad masonry means weak walls. Here, the distance between bricks is uneven, the joints between bricks are not staggered far enough apart, and the joints themselves are not completely filled with mortar.



GOOD MASONRY

Here, the bricks are horizontally straight, vertically plumb and the joints between bricks are 1.2 cm thick or smaller.

Plasterwork Defects

The common defects in plasterwork :

- Grinning - positions of mortar joints are visible
- Lack of hardness in plaster - due to use of less cement , drying of water
- Lamination - Debonding of plaster often noticed as a hollow sound when tapped
- Crack - may result from structural crack in the wall
- Blistering - occurs when small patches swell out beyond the plane of the plastered surface

Grinning

Crack

Blistering

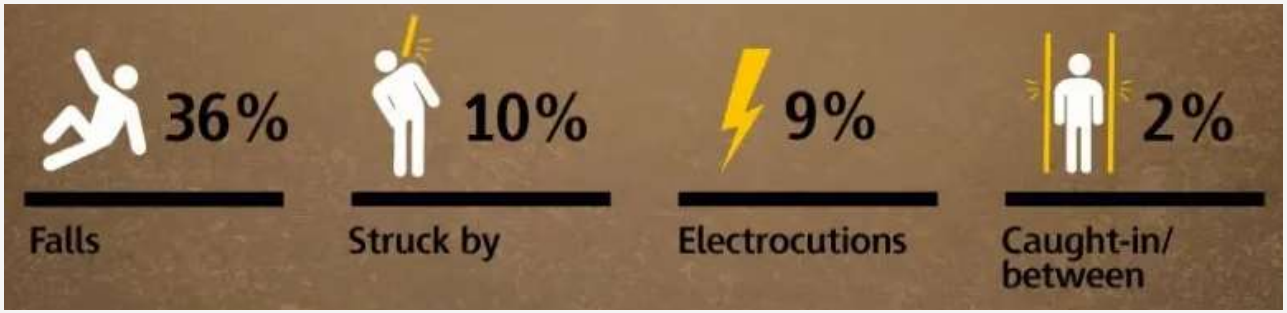
Occupation Safety & Health

SAFETY IS EVERYBODY'S RESPONSIBILITY		**AVOID HAZARDS : PREVENT ACCIDENTS**

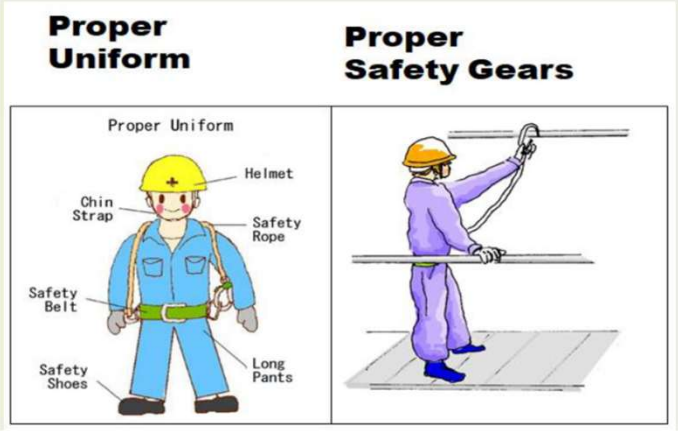
- All project staff must be given training on Site Safety Management, prior to commencing Construction Engineering Activities on site
- It is part on Contractor's responsibility to ensure that site is safe for work & kept tidy during all working hours, every day, every shift
- It is also, required to ensure that all necessary amenities are available on site for workers & staff, such as drinking water, toilets, rest sheds etc.
- Medical aid to meet immediate requirement is also, an amenity to be provided on priority basis
- Use of PPEs should be a must for all Staff & Workers on site
- Onsite regular & frequent training must be given, related to methods to keep site & work safe

Occupation Safety & Health

Some common causes of accidents at construction sites



Use Appropriate PPE



Occupation Safety & Health

Standard Practices For A Safe Construction Site

TOOL BOX TALK

- Ensure daily tool box talk to co-workers & site labour by contractor about safety concerns & precautions

GENERAL

- Site is properly barricaded & secure
- First Aid Box Available
- Clean Drinking Water Available
- Rest Area for labour
- Toilet Facility for staff & Labour
- Emergency Plan is Available
- Waste & Rubbish is properly disposed
- Proper Housekeeping is done

PERSONAL PROTECTIVE EQUIPEMENT

- Helmet
- Safety Boots
- Safety Jacket

Occupation Safety & Health

Standard Practices For A Safe Construction Site

SCAFFOLDS
- Set up on level, stable footing
- Platform is appropriate width

WORK AT HEIGHT
- Fall protection provided for work at height
- Harness is worn properly and properly attached

HEAVY EQUIPMENT & VEHICLE
- Safety measures adopted for heavy equipment & vehicle operating at site

LIFTING
- Safety measures adopted for cranes operating at site

MACHINE HAZARDS
- Workers are trained on the use of power tools.
- Specific PPE used while working

MANUAL HANDLING
- Workers are trained and follow standard practices for manual handling

FIRE HAZARDS
- All flammable materials- fuel, gas cylinders are stored in designated areas
- Fire extinguishers are available as required

ELECTRICAL HAZARDS
- Overhead and underground electrical power lines are identified and avoided.
- Loose wiring checked & rectified
- Distribution boxes are secured

EXCAVATIONS
- Barricades around excavation
- Safe slope of excavation & shoring
- Ladder access for excavation

LADDERS
- Defect Free & Correct size for the job
- Firm foundation & properly secured

NIGHT WORK
- Proper illumination at site

Thank You for your Participation!!

Questions ??

Have any doubts
You can reach out to me on WhatsApp or email
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