“ BUILD BACK BETTER”

...The SAFETY of our school children and countrymen lies in your dedication, vigilance and technical judgement as you build residential houses that shall protect their occupants and school buildings that shall serve as future evacuation centers for the displaced families during calamities...they are counting on YOU!

IN COOPERATION WITH:
MOHRI & P.A. ASSOCIATES INC.

SIMPLIFIED CONSTRUCTION HANDBOOK FOR SCHOOL BUILDINGS

FOR SUPERVISING ARCHITECTS, CIVIL ENGINEERS, CONTRACTORS & CONSTRUCTION FOREMEN

May 2014

PREPARED BY :
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
JAPAN INTERNATIONAL COOPERATION AGENCY

IN COLLABORATION WITH:
DEPARTMENT OF EDUCATION

Acknowledgements:

- National Structural Code of the Philippines (NSCP), version Six; ASEP
- Masons and Builders Library volume 1 (revised edition) by Louis M. Dezettel; revised by Tom Philbin
- Architectural & Construction Data - Book 9 by George S. Salvan
- Manual on Construction Methods and Techniques for Buildings, DPWH
- Basic Construction Training Manual for Trainers, Heini Muller
- RSmeans- Illustrated Construction Dictionary
- Building Construction Illustrated
- TEEP "A Layman's Guide to the Construction of a One-Storey, Two-Classroom School Building in 60 days"

This handbook can likewise be used for the construction of residential houses.

Should there be any conflicting statements, illustrations between this handbook and the construction plans and specification, the plans and specification shall prevail.

Appendix B

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS — **CONCRETE POURING REQUEST**

PROJECT:			
LOCATION:			
DATE REQUESTED:			CPTR NO.:
STRUCTURE	AREA/FLOOR LEVEL:		ACTUAL INSPECTION DATE/TIME:
GRIDLINE:			

CHECK THAT THE FOLLOWING COMPLY WITH APPROVED SUBMITTALS FOR CONSTRUCTION DRAWINGS AND TECHNICAL SPECIFICATIONS.

POURING REQUEST

Subject Area/ Structure	:	
Concrete Strength	:	
Slump	:	
Elevation (From Reference point)	:	
Date of Scheduled Pouring	:	Actual volume:
Estimated Volume	:	Time Completed:
Time Started	:	
Number of Sample	:	

COMPONENTS	COMPLIED DFC	YES	NO	N/A	REMARKS	ACTIONS REQUIRED
CHECKLISTS						
A. Formworks						
1. Correct Elevation/ Layout		☐	☐	☐		
2. Required dimension / thickness satisfied		☐	☐	☐		
3. Squareness, Plumbness, Levelness achieved		☐	☐	☐		
4. Adequate/Appropriate shoring, braces and supports		☐	☐	☐		
5. Approved form – oil applied		☐	☐	☐		
a. Wax based for Steel forms		☐	☐	☐		
b. Resin based for Phenolic Plywoods		☐	☐	☐		
6. Cleanliness (free from saw dust, concrete laitances, loose tie wires, debris and alike)		☐	☐	☐		
7. Approved construction joint key		☐	☐	☐		
B. Rebar						
8. "For Construction" Plan, Issued Date: _____		☐	☐	☐		
9. Approved Rebar Cutting Lists, Ref. No: _____		☐	☐	☐		
10. Passed the Required Tests		☐	☐	☐		
11. Free from Scaling, Laitances and other impurities		☐	☐	☐		
12. Concrete spacer minimum concrete covers		☐	☐	☐		
a. For Slab (1.0meter space on center both ways)		☐	☐	☐		
b. For Beams (Bottom/Side Bars, 2pcs at every 0.80meter)		☐	☐	☐		
13. Correct quantity and spacing		☐	☐	☐		
14. Correct splice location / length and development lengths		☐	☐	☐		
15. Minimum stirrups / ties installed above concrete termination for Vertical Structures		☐	☐	☐		
16. Approved shear bars / keys at construction joints		☐	☐	☐		
C. MEPF Checklists **Reference No.**						
17. Accomplished Electrical _____ Pre-Concreting Checklist (QC-MEPF-001)		☐	☐	☐		
18. Accomplished Plumbing / _____ Sanitary Pre-Concreting checklist (QC-MEPF-002)		☐	☐	☐		
19. Accomplished Fire Protection _____ Pre-Concreting checklist (QC-MEPF-003)		☐	☐	☐		
20. Approved Penetrations		☐	☐	☐		
21. Accomplished Civil Dowels, etc.		☐	☐	☐		
FORM STRIKING						

REMARKS: DFC= Dimensions for Compliance

INSPECTED BY:	CHECKED BY:	APPROVED BY:
Constractor's Proj. Engineer	DPWH-Inspector	DPWH- Project Engineer

DISTRIBUTION: ☐Contractor ☐QC Engineer ☐Inspector ☐Project Engineer

Appendix A

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS — **FORMS CLOSURE REQUEST**

PROJECT:			
LOCATION:			
DATE REQUESTED:		CPTR NO.:	
STRUCTURE:	AREA/FLOOR LEVEL:	ACTUAL INSPECTION DATE/TIME:	
GRIDLINE:			

CHECK THAT THE FOLLOWING COMPLY WITH APPROVED SUBMITTALS FOR CONSTRUCTION DRAWINGS AND TECHNICAL SPECIFICATIONS.

COMPONENTS	COMPLIED				REMARKS	ACTIONS REQUIRED
	DFC	YES	NO	N/A		
REINFORCING STEEL CHECKLIST						
1. Bars are not misbent or damaged		☐	☐	☐		
2. Bars are free of dirt, loose mill scale, heavy rust, grease or other deleterious materials		☐	☐	☐		
3. Bar identifications are intact and legible before use		☐	☐	☐		
4. After placing reinforcing bars:		☐	☐	☐		
a. Bars are free of loose mortar, rust, grease and other substance capable of destroying bond		☐	☐	☐		
b. Rebar type, size, fabrication, and positioning in accordance with the drawing.		☐	☐	☐		
c. Total Quantity of rebars per schedule		☐	☐	☐		
d. Minimum clearance distance between bars is equal to nominal diameter of bar but not less than 1 inch		☐	☐	☐		
e. For parallel bars in layer or mats the minimum clear distance between layers is equal to the diam.of the bar but not less than 1 inch		☐	☐	☐		
f. No.11 bars and smaller bar are lap spliced. Larger bars are spliced by welding or other type position connection		☐	☐	☐		
g. Lap length of splices is according to specifications and drawings		☐	☐	☐		
h. Cover of bars meet or exceeds the minimum requirements. Spacers adequate.		☐	☐	☐		
i. Hook size, length, spacing, degree according to specifications and drawings.		☐	☐	☐		
j. Reinforcement is adequately supported. Columns, tie beams rest on gravel base.		☐	☐	☐		
k. Extra bars, stiffeners and others, according to plans and specifications.		☐	☐	☐		
l. Field bending or straightening or rebars is done in accordance with the specification		☐	☐	☐		
m. Rebent or straightened bars are free of cracks or damage.		☐	☐	☐		
FORMWORKS						
5. Shape, line and grade, dimensions of form- in place		☐	☐	☐		
6. Cleaning and oil coating present over whole form area and adequate		☐	☐	☐		
7. Tightness of joints and bracings adequate per approved submittals and drawings		☐	☐	☐		
8. Location of construction /control/expansion joints		☐	☐	☐		
9. Installation of block-outs and pipes embedment		☐	☐	☐		
10. Adequate shoring supports on firm base		☐	☐	☐		
11. Vertical and Horizontal Control within tolerances		☐	☐	☐		
OPENINGS						
12. Door openings according to drawings		☐	☐	☐		
13. Window openings according to drawings		☐	☐	☐		
14. Lintel beams		☐	☐	☐		
15. Stiffener columns		☐	☐	☐		
PENETRATIONS (MEPF)						
16. Pipe sleeves spacing, location, type according to drawings		☐	☐	☐		
		☐	☐	☐		
		☐	☐	☐		

REMARKS: DFC = Dimension for Compliance

INSPECTED BY:	CHECKED BY:	APPROVED BY:
Contractor's Proj. Engineer	DPWH-Inspector	DPWH- Project Engineer

DISTRIBUTION: ☐Contractor ☐QC Engineer ☐Inspector ☐Project Engineer

FOREWORD

The destruction caused by natural calamities that had severely affected some parts of the country has brought about the need to build back better buildings, particularly school buildings, with disaster-resilient standards.

Thorough assessments made on the calamity-damaged school buildings, show that proper construction methodologies, effective project supervision and quality control are important factors that would yield better and resilient structures ensuring the safety of the primary occupants – the school children.

The task of rebuilding these damaged school buildings is so enormous. Thus, given the limitation of highly experienced technical professionals, this SIMPLIFIED CONSTRUCTION HANDBOOK for school buildings is designed to help the supervising Architects/ Engineers, Contractors and Construction Foremen as an easy reference for checking, monitoring and overseeing the construction and repair activities.

The typical methods as illustrated and simple descriptions in this Handbook are meant to explain the critical processes in building construction, from mobilization to demobilization – including the importance of laying out the building on the ground to the proper construction methodologies up to its completion.

I therefore enjoin all those concerned technical personnel to use this Handbook as easy reference and proper guidance.

ROGELIO L. SINGSON
Secretary
Department of Public Works and Highways

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JOB CONTROL FORMS

There are two essential job control forms that need to be accomplished by the inspector before concrete pouring on a specific structural member, as follows:

1. Form Closure Request (refer to Appendix A)

a. The Contractor's Project Engineer conducts a thorough inspection of installed formworks, reinforcing bar works, utility roughing-ins and concrete spacers to make sure that they comply with the construction plans, specification and sound engineering practices. Affixes his/her signature on the "Inspected By" box;

b. The DPWH Project Inspector checks and verifies the same to check on compliance and affixes his/her signature in the "Checked By" box;

c. The DPWH Project Engineer approves the Form Closure Request by signing the "Approved By" box.

2. Concrete Pouring Request (refer to Appendix B)

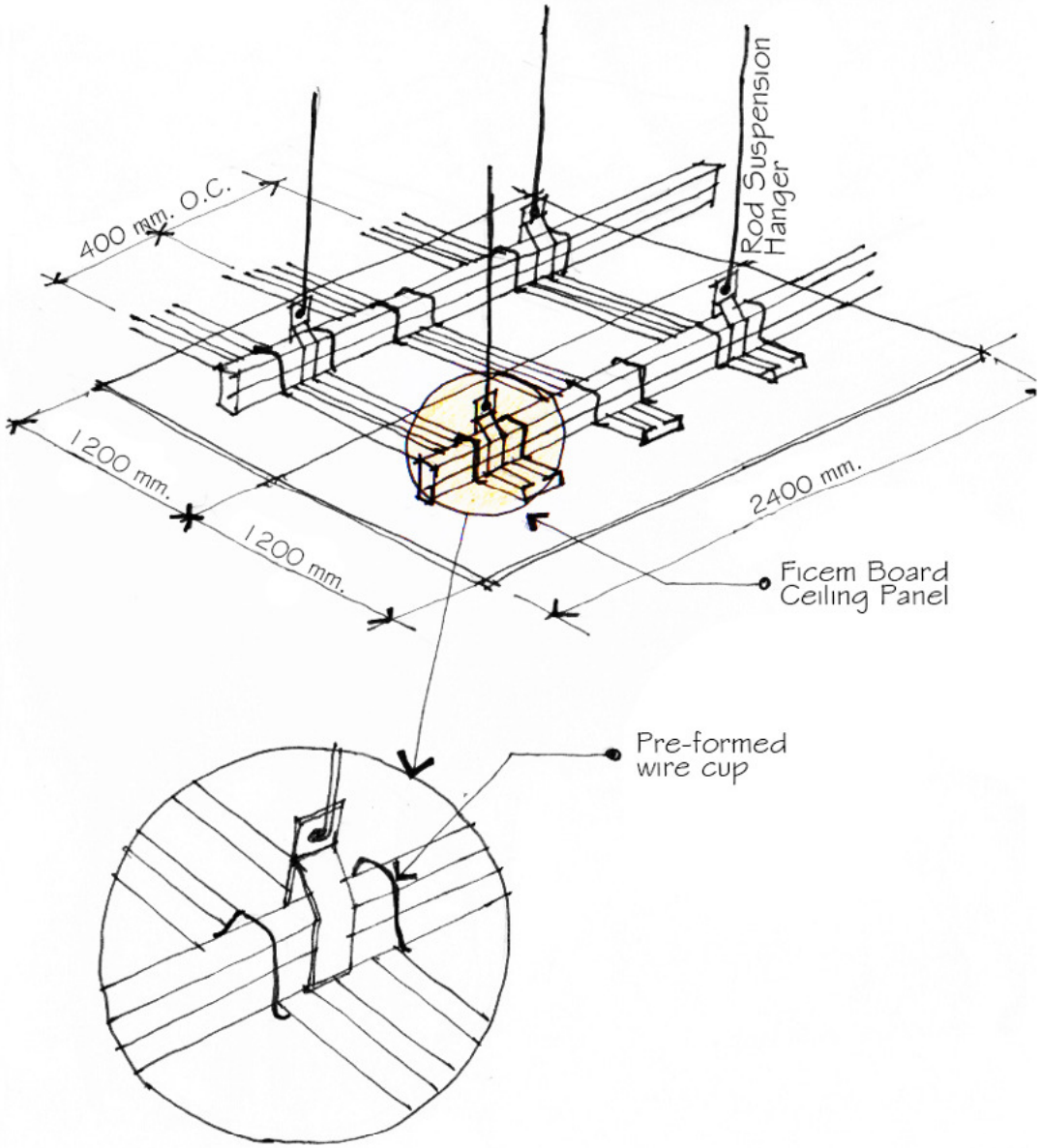
a. The Contractor's Project Engineer conducts a thorough inspection of installed formworks, reinforcing bar works, utility roughing-ins and concrete spacers to make sure that they comply with the construction plans, specification and sound engineering practices. Affixes his/her signature on the "Inspected By" box;

b. The DPWH Project Inspector checks and verifies the same to check on compliance and affixes his/her signature in the "Checked By" box;

c. The DPWH Project Engineer approves the Concrete Pouring Request by signing the "Approved By" box.

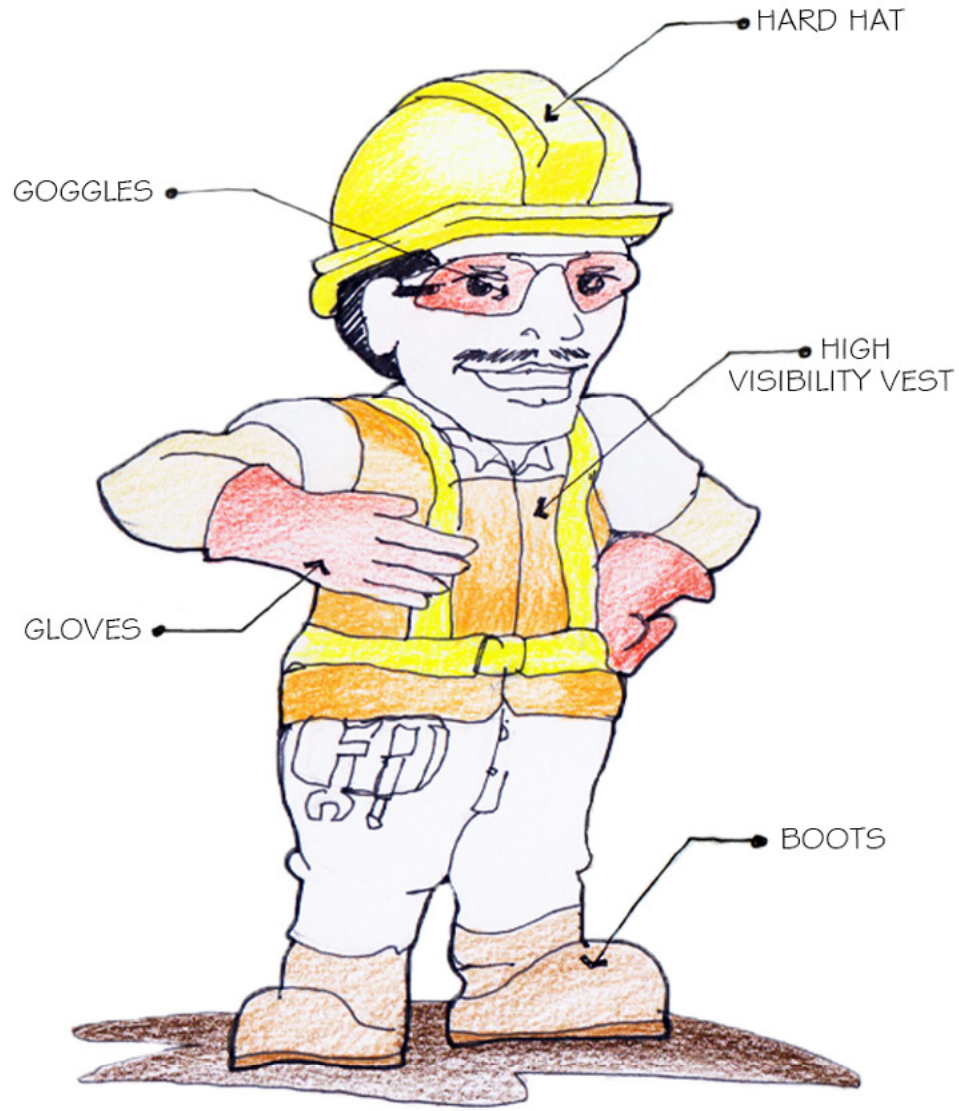
Note: These forms should always be readily available on site and shall be submitted by the Contractor to the DPWH Project Engineer for appropriate filing.

CEILING WORKS



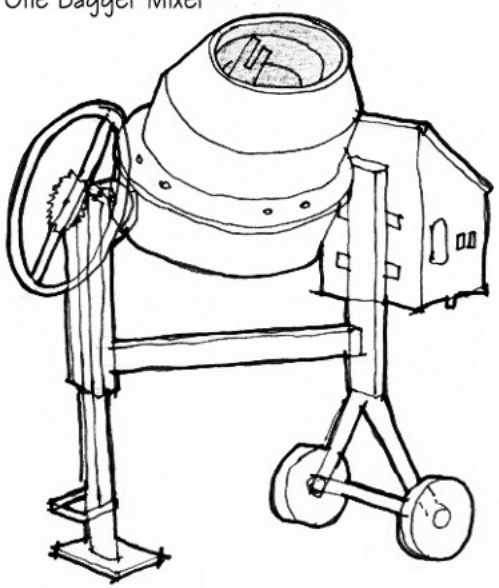
SAFETY GEAR

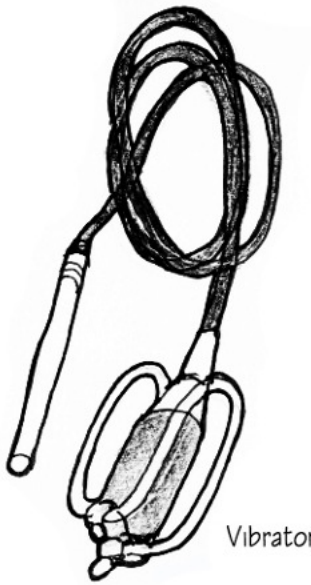
Safety gear is to be supplied to ensure the safety and well-being of the construction workers.



BASIC CONSTRUCTION EQUIPMENT

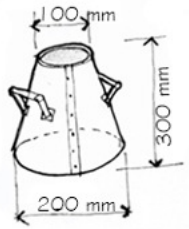
One Bagger Mixer



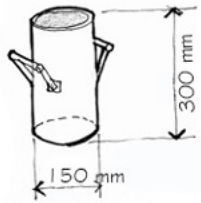


Vibrator

Truncated Cone Tester



Metal Cylinder



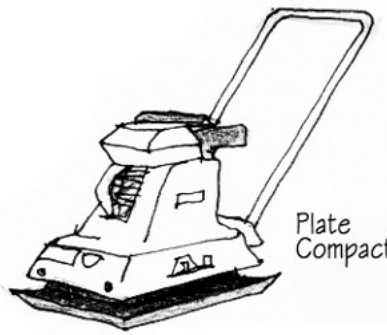
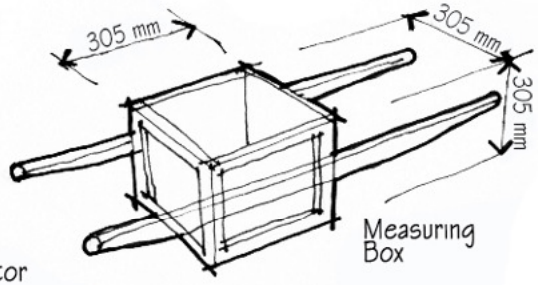
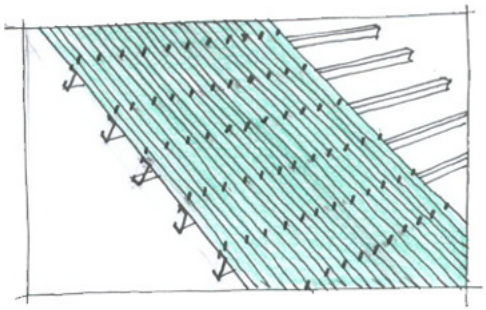


Plate Compactor

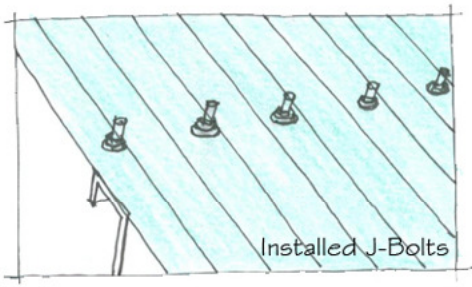


Measuring Box



Installation

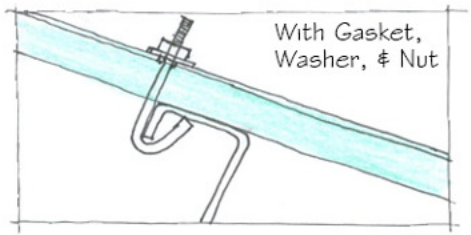
In the installation of J-Bolt, two (2) men are required to work simultaneously. One will insert the bolt through the hole from the indoor and the other will fasten the nut outdoor.

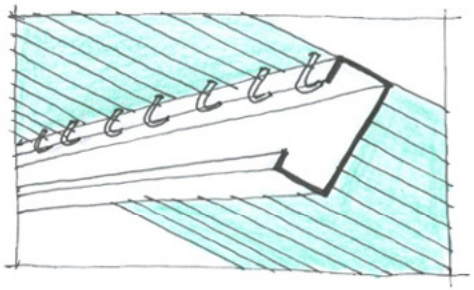


Installed J-Bolts

Before fastening the nut, fit a neoprene gasket then a washer bigger than the gasket.

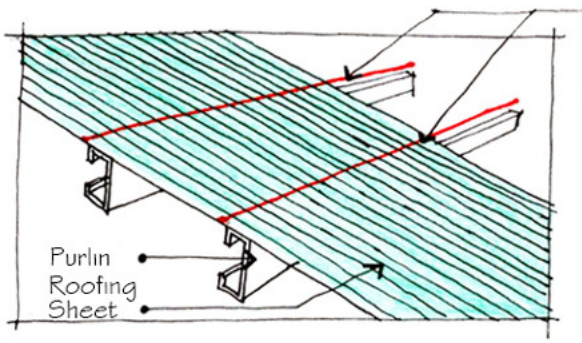
In fastening the nut, precaution must be observed to avoid warping of the G.I. Sheet.





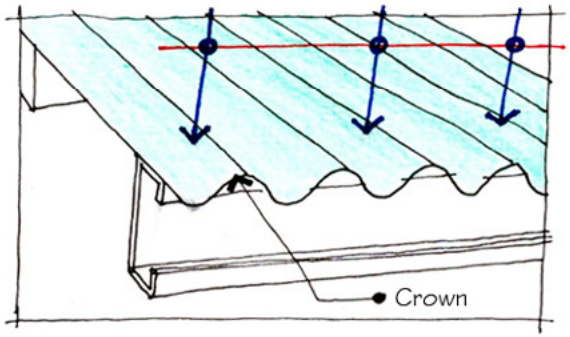
Hook of the J-bolt on the purlin must be perpendicular to the G.I. Sheet.

J - BOLT INSTALLATION GUIDE



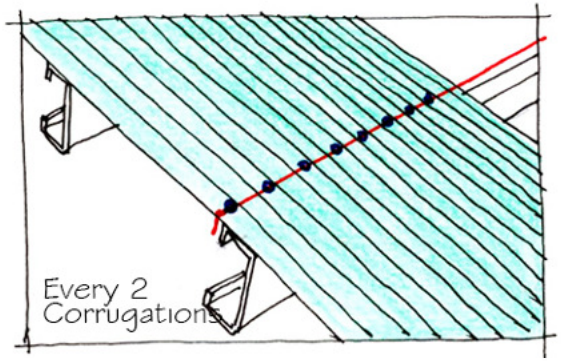
Laying Out

In laying out the placement for the J-Bolt, make sure that it will be alligned near enough the lip of the purlin avoiding it to be drilled when making holes. A guide chord may be stretched out from end to end of the purlin to establish the desired alignment.



Drilling

After laying out, drilling points should be located at crown every other two corrugations of the roofing material (G.I. Sheets).

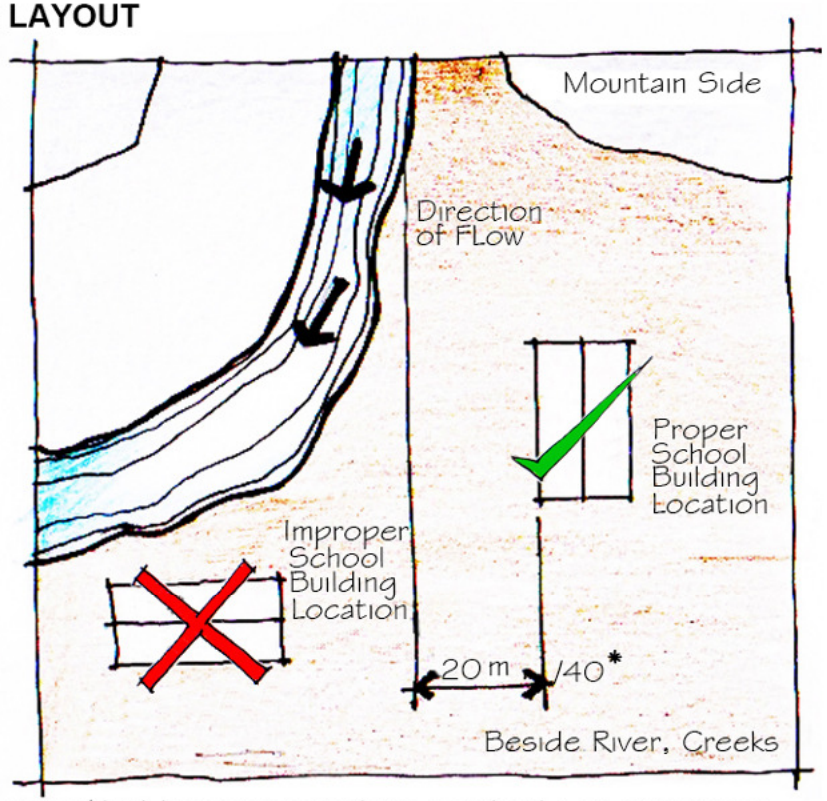


SAMPLING & TESTING REQUIREMENTS OF BASIC MATERIALS:

TEST	FREQUENCY OF TEST	NO. OF SAMPLES
A. WATER 1. Quality Test (PH Level)	one on each source	1
B. CONCRETE MASONRY UNIT (Required Units:) 1. Absorption Test 10 pcs. 2. Compressive Test 10 pcs.	1 for every 20,000 pcs. delivered at site	
C. CONCRETE 1. Trial Mix (For cases where ready mix is to be used) 2. Slump Test 3. Temperature Test 4. Compressive Test	on plant every delivery every delivery every delivery	1 5 5 5
D. REINFORCING BARS 1. TENSILE TEST 1.1 Chemical Composition 1.2 Mechanical Composition 1.3 Bending	1 for every 10,000 kgs. or fraction thereof for each size	3 per diameter
E. FINE AGGREGATES 1. Sieve Analysis 2. Fineness Modulus 3. Bulk Specific Gravity 4. Absorption 5. Mortar Strength Soundness 6. Organic Impurities 7. Unit Weight 8. Percent Clay Lumps	1 per $75m^3$ or fraction thereof	3
F. COURSE AGGREGATES 1. Sieve Analysis 2. Fineness Modulus 3. Bulk Specific Gravity 4. Absoption 5. Abrasion 6. Soundness 7. Unit Weight	1 per 1,500 m^3 or fraction thereof	3
G. CEMENT (10 kgs. per 1000 bags)	1 for every 2,000 or fraction thereof	3
H. G.I. SHEETS (Basemetal)		
I. STEEL COMPONENTS (ex. angle bars, C-purlins, etc) (with Mill Certificate)	1 for every 10,000 kgs. or fraction thereof for each size	3 per section

Testing of materials should be done in DPWH Testing Laboratories or DPWH Accredited Testing Laboratories.

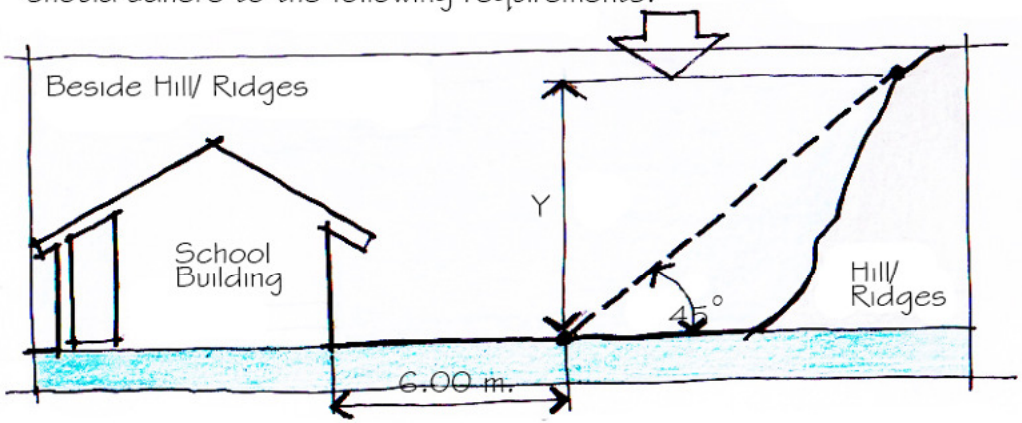
SITE LAYOUT



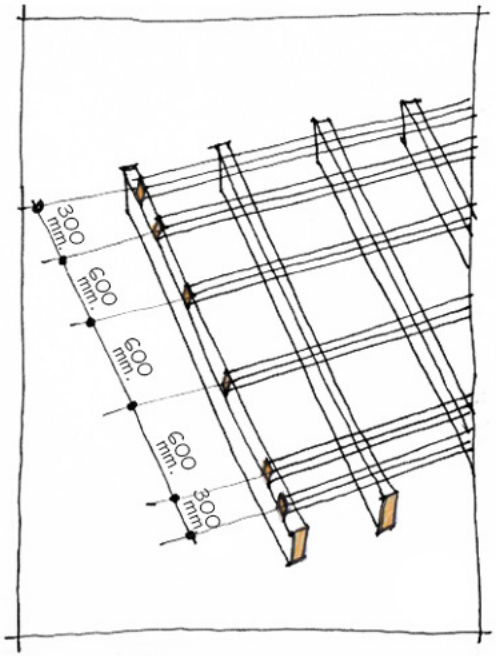
Structures/ buildings near or along riverbanks or waterways.

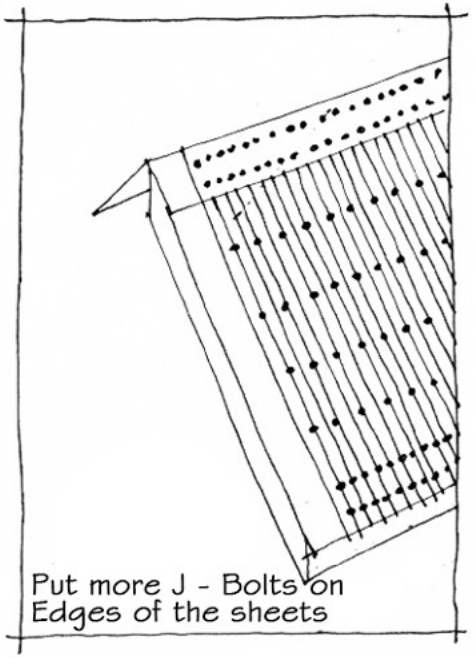
* Adopt 40 M setback along shorelines reckoning from the highest water level during hightide.

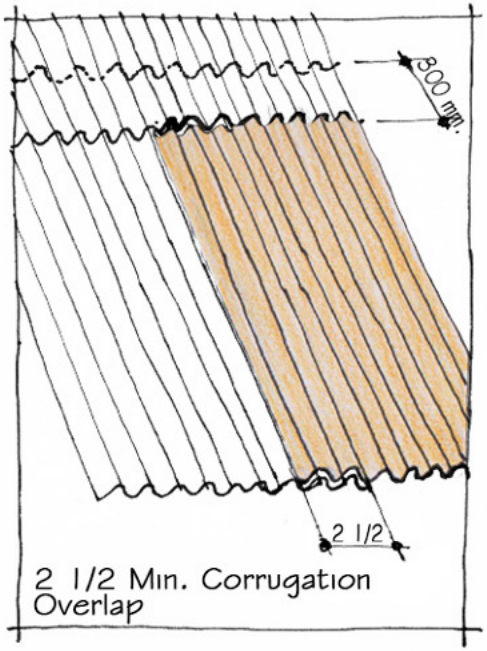
- Structures/ buildings on or adjacent to ground slopes exceeding 100% should adhere to the following requirements.

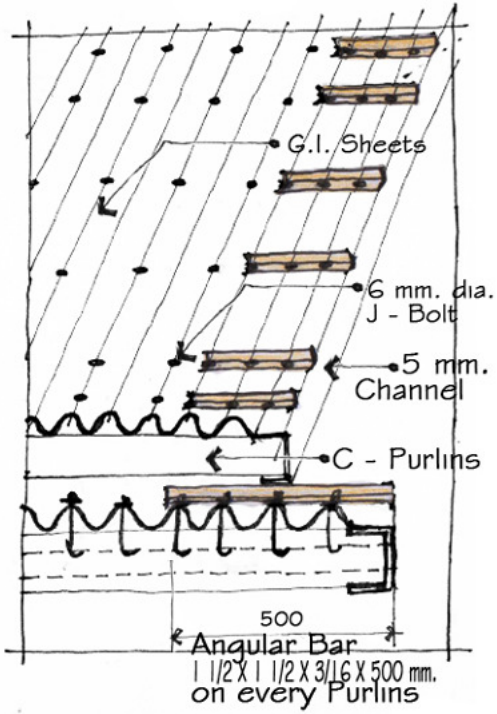


ROOFING SHEET INSTALLATION

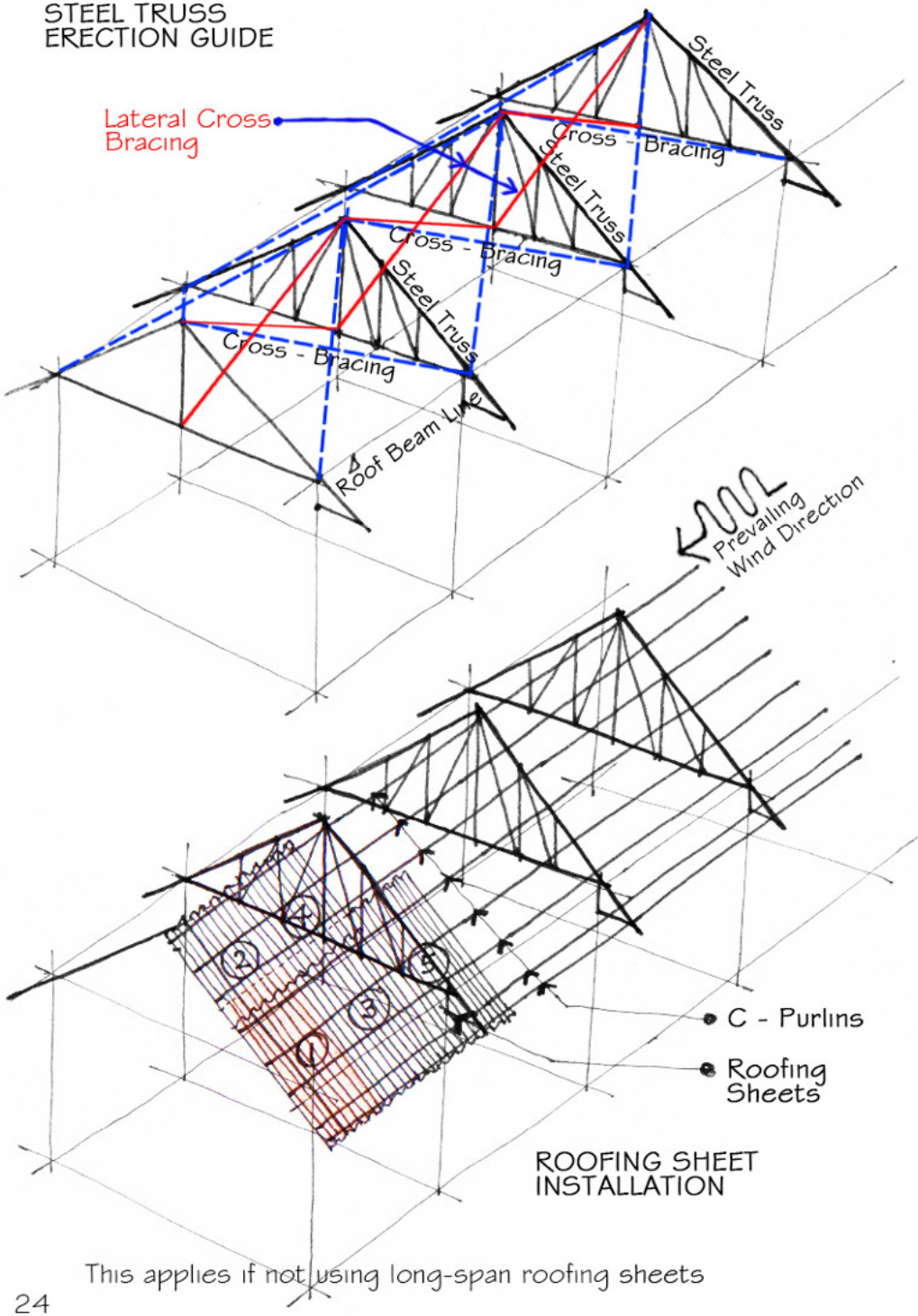






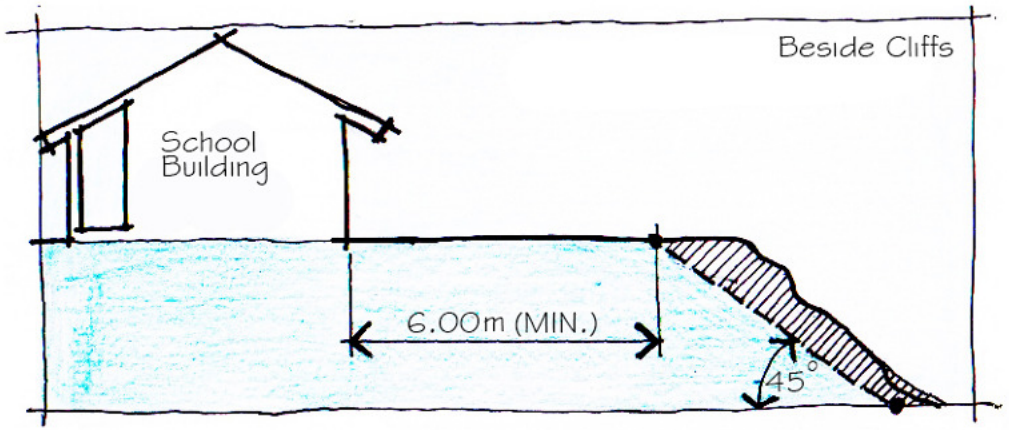


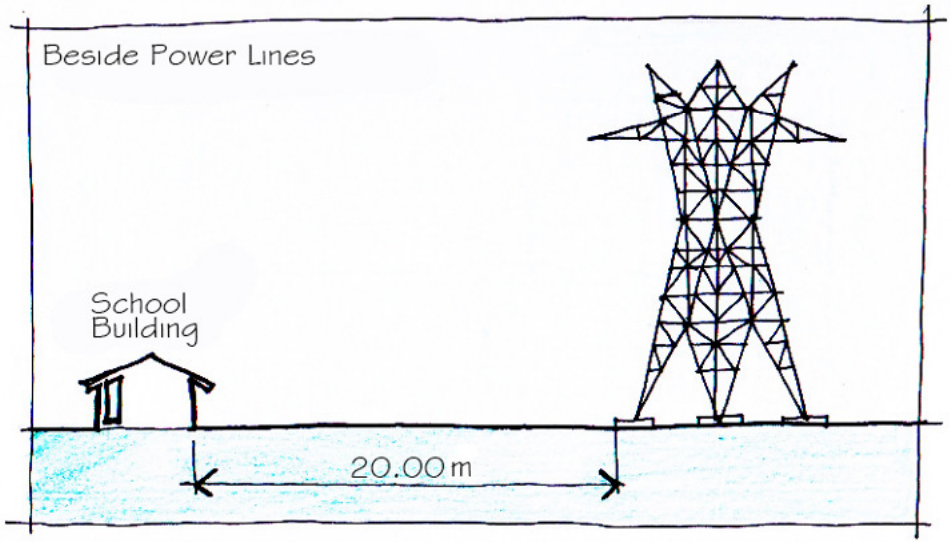
STEEL TRUSS ERECTION GUIDE

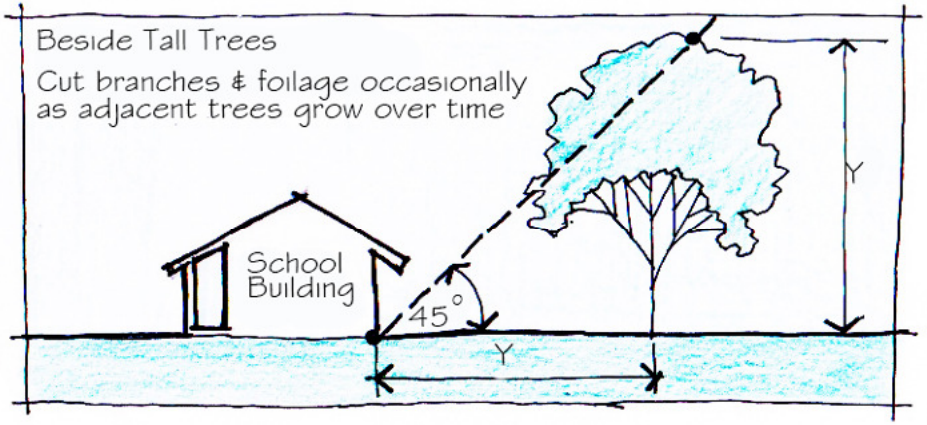


ROOFING SHEET INSTALLATION

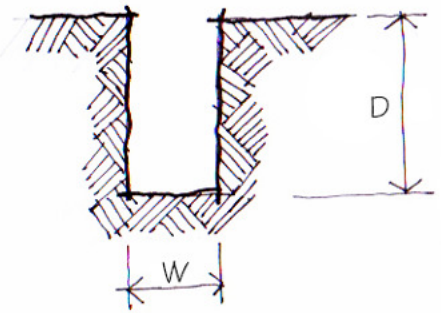
This applies if not using long-span roofing sheets



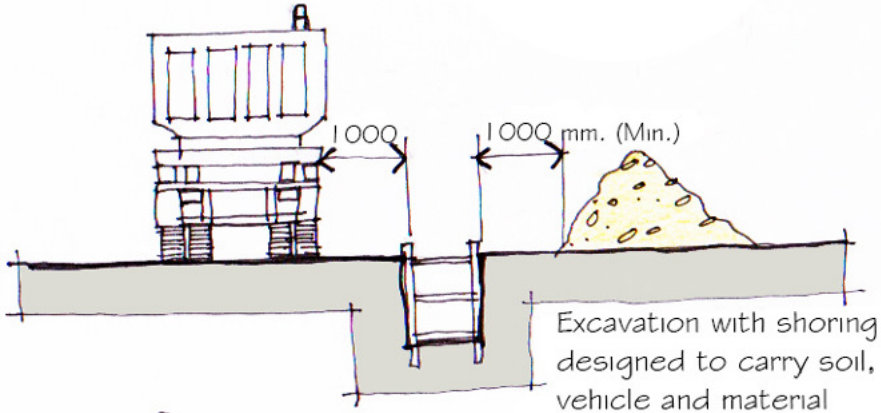




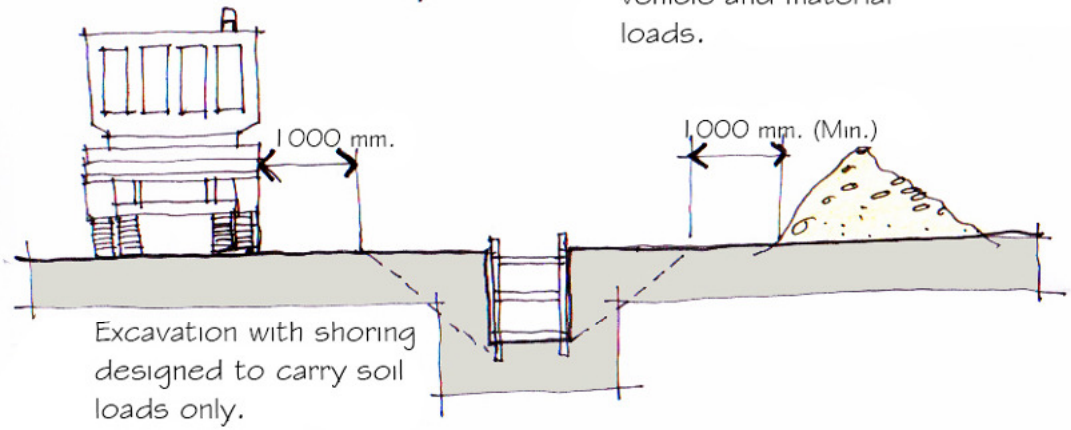
EXCAVATION AND SHORING



Before a worker enters an excavation site (which is 1.5 Meters in depth or more than twice the width of the trench). A support structure is needed or the excavated walls must be sloped at an appropriate angle.



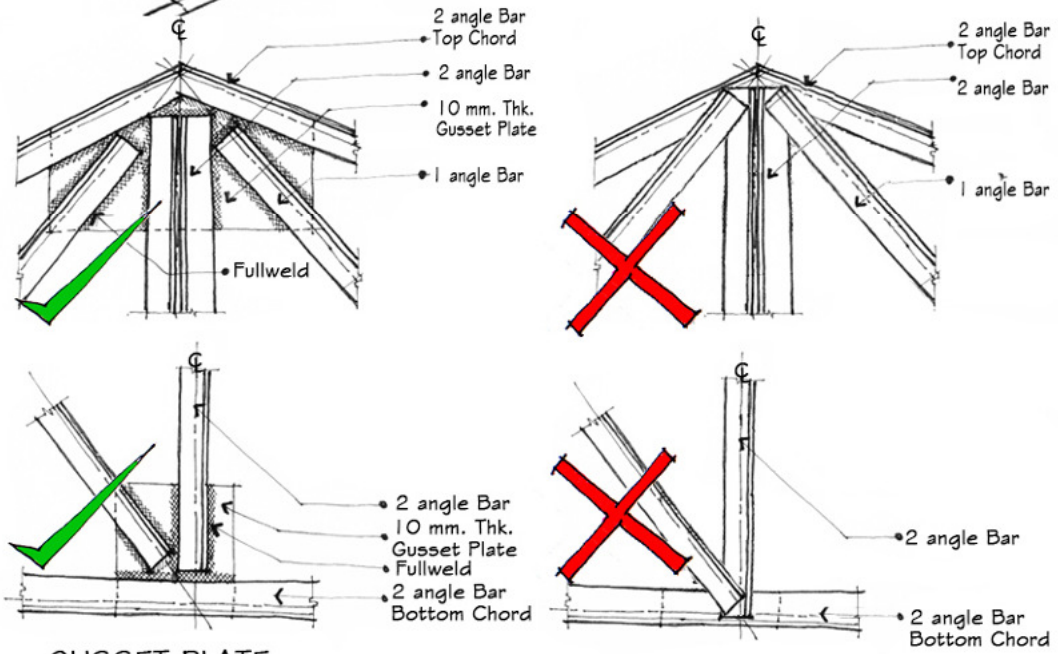
Excavation with shoring designed to carry soil, vehicle and material loads.



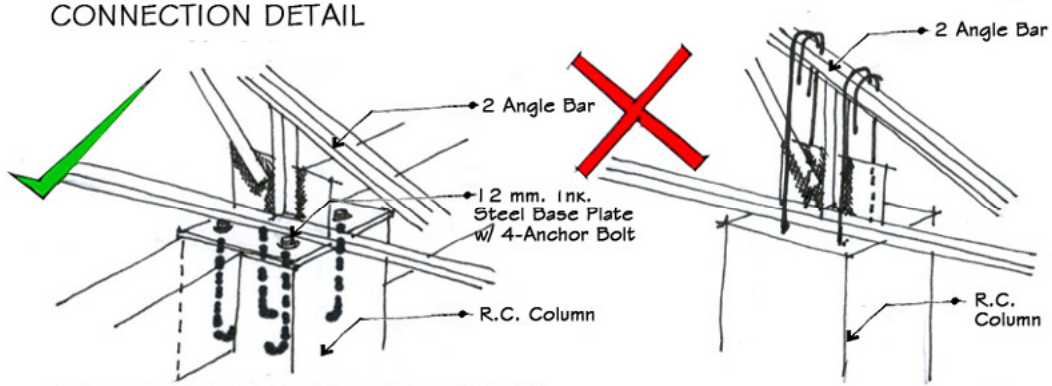
Excavation with shoring designed to carry soil loads only.

ROOF FRAMING WORKS

STEEL TRUSS
FABRICATION at GROUND LEVEL



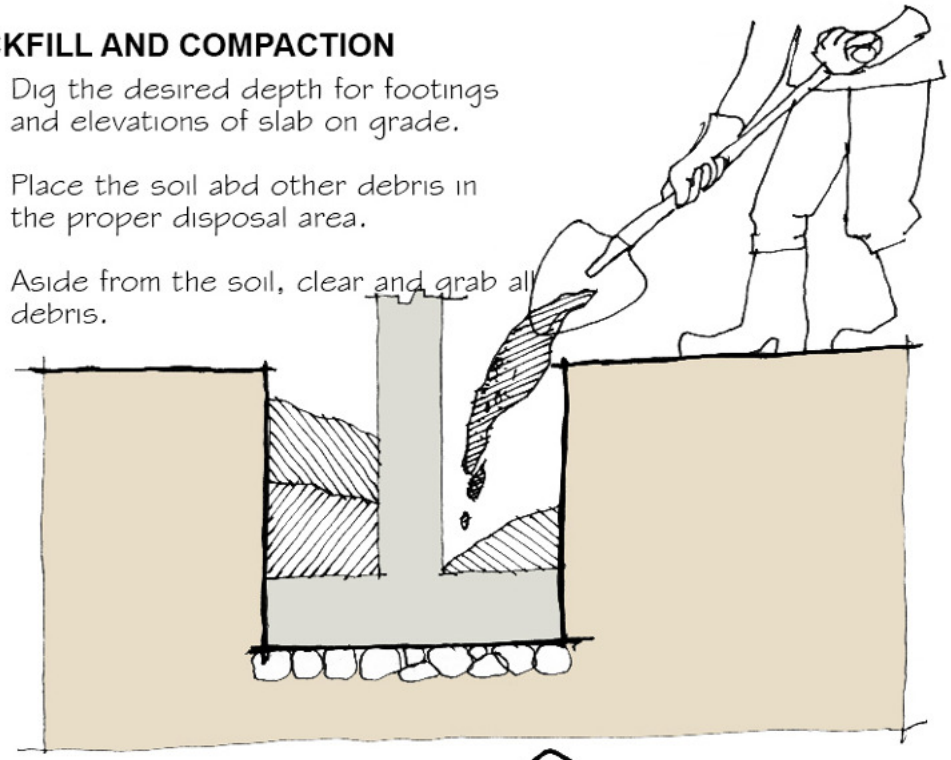
GUSSET PLATE
CONNECTION DETAIL



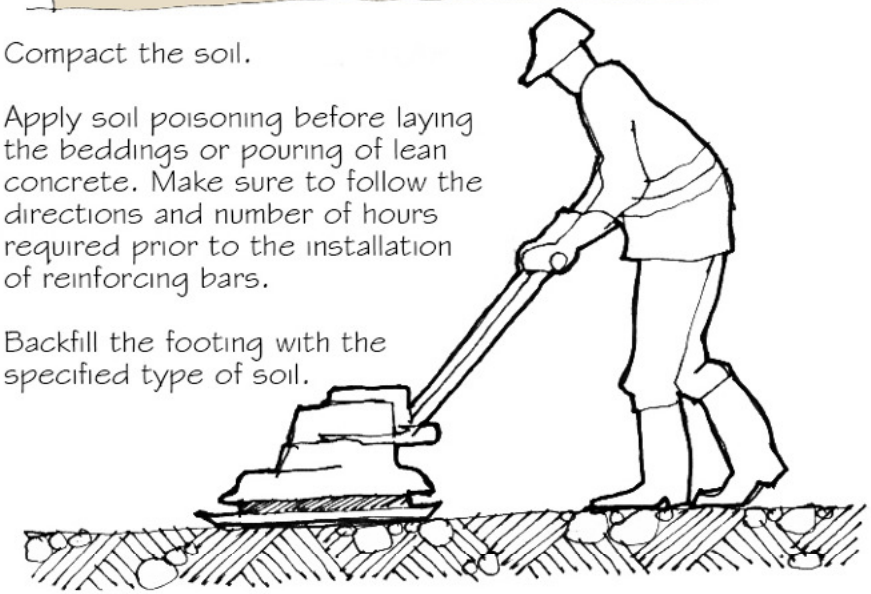
BASE PLATE ANCHORAGE DETAIL

BACKFILL AND COMPACTION

- Dig the desired depth for footings and elevations of slab on grade.
- Place the soil abd other debris in the proper disposal area.
- Aside from the soil, clear and grab all debris.

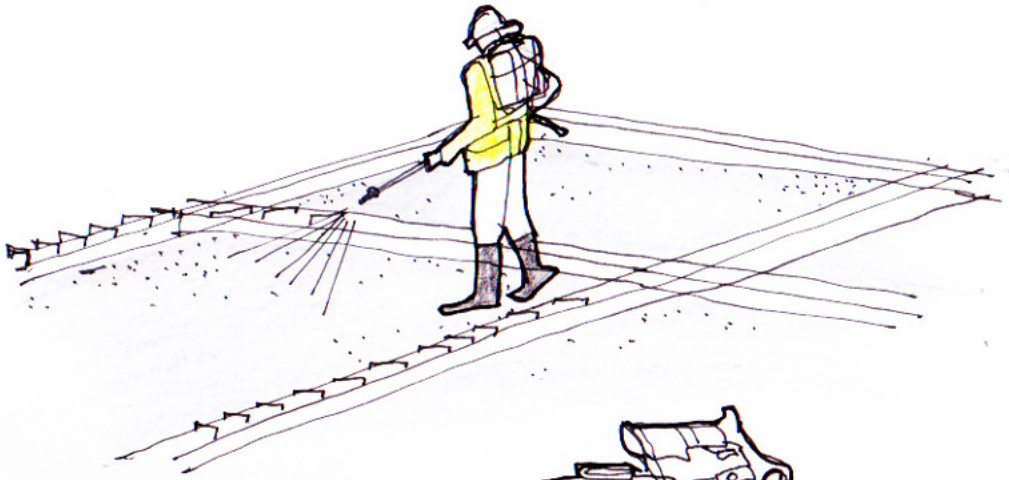


- Compact the soil.
- Apply soil poisoning before laying the beddings or pouring of lean concrete. Make sure to follow the directions and number of hours required prior to the installation of reinforcing bars.
- Backfill the footing with the specified type of soil.

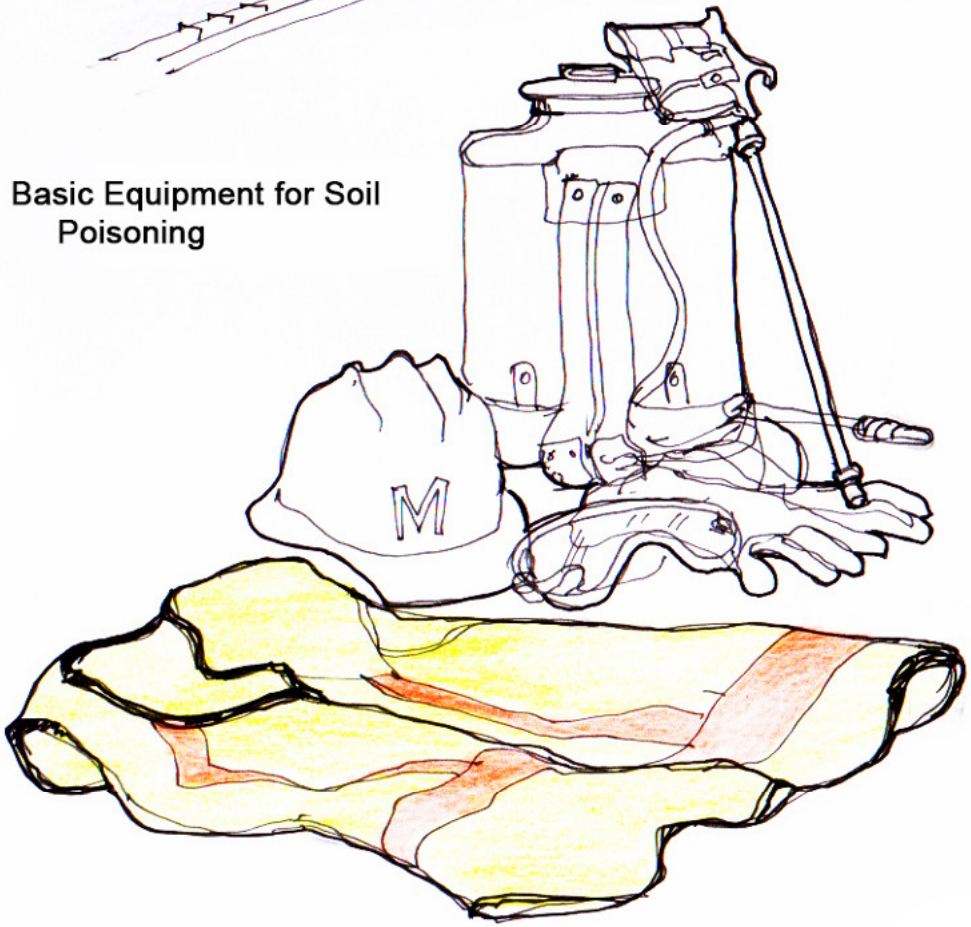


- Before pouring of slab on grade make sure that the soil is well compacted. Compact the soil at every 200 mm layer prior to soil poisoning. Laying of gravel bed and installation of reinforcing bars.

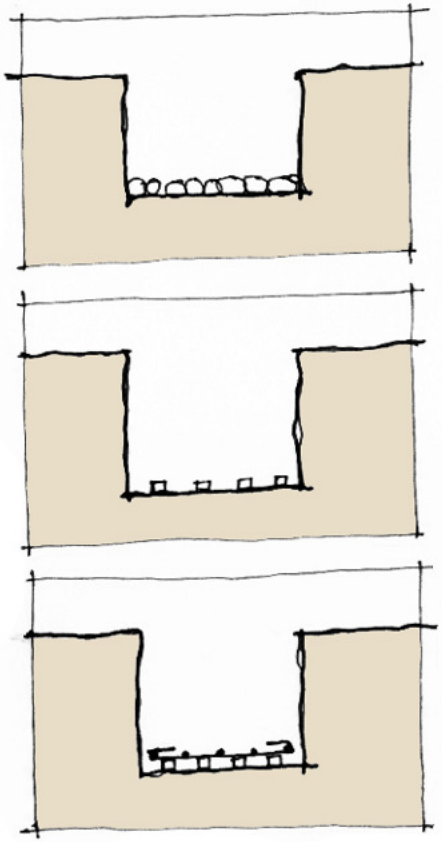
SOIL POISONING



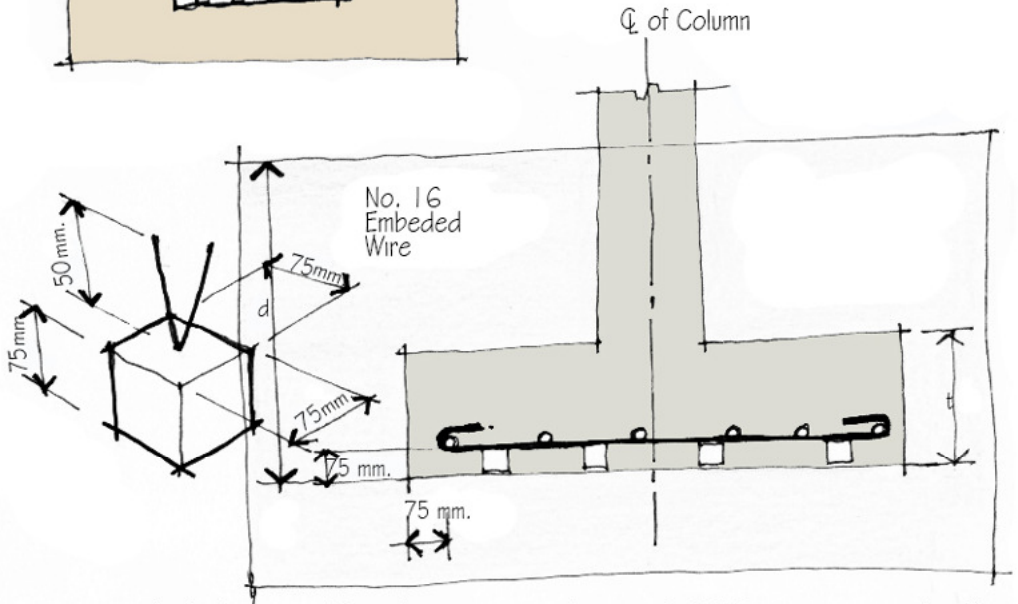
Basic Equipment for Soil Poisoning



FOUNDATION WORKS

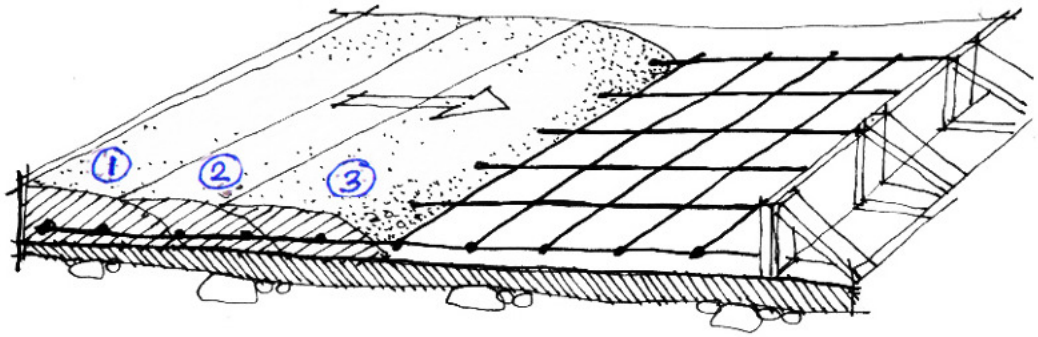


- Dig the required footing from the natural grade line.
- Pour 50 mm or 100 mm lean concrete or place a 100 mm gravel bed.
- Provide 75mm thick spacer with 600 mm interval bothways. The minimum compressive strength of this spacer should be 1000 psi.
- Lay the reinforcing bars and tie them with no. 16 G.I. wires.
- Provide starter bars or dowels to ensure that the forces are transferred to footing
- Pour concrete up to the specified thickness.



1:4 Cement/ Sand ratio to achieve 1,000 psi strength of concrete spacer

CONCRETE POURING OF SLAB ON FILL



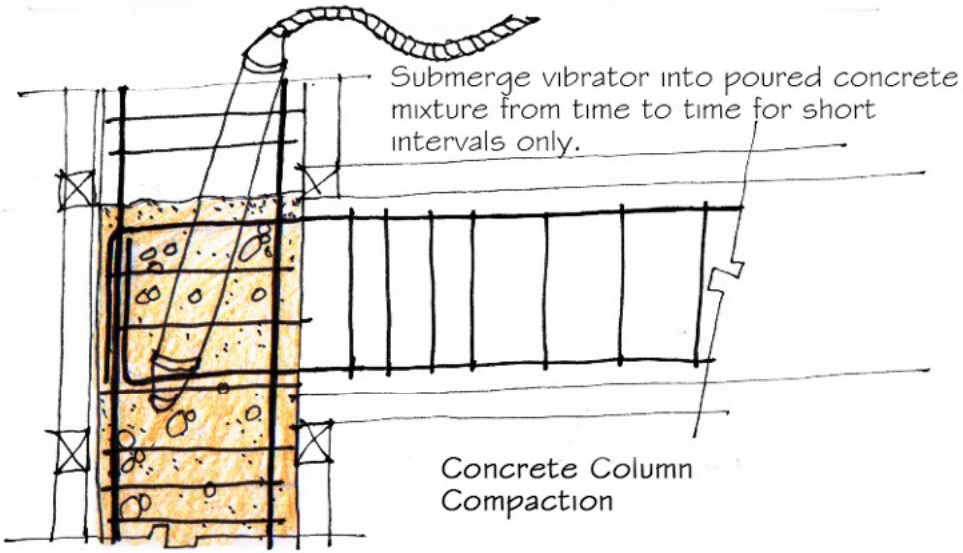
Proper Placing

The right way to pour concrete on grade is to start from the farthest point working back to the source of concrete mix.

Before placing concrete, make sure the forms are:

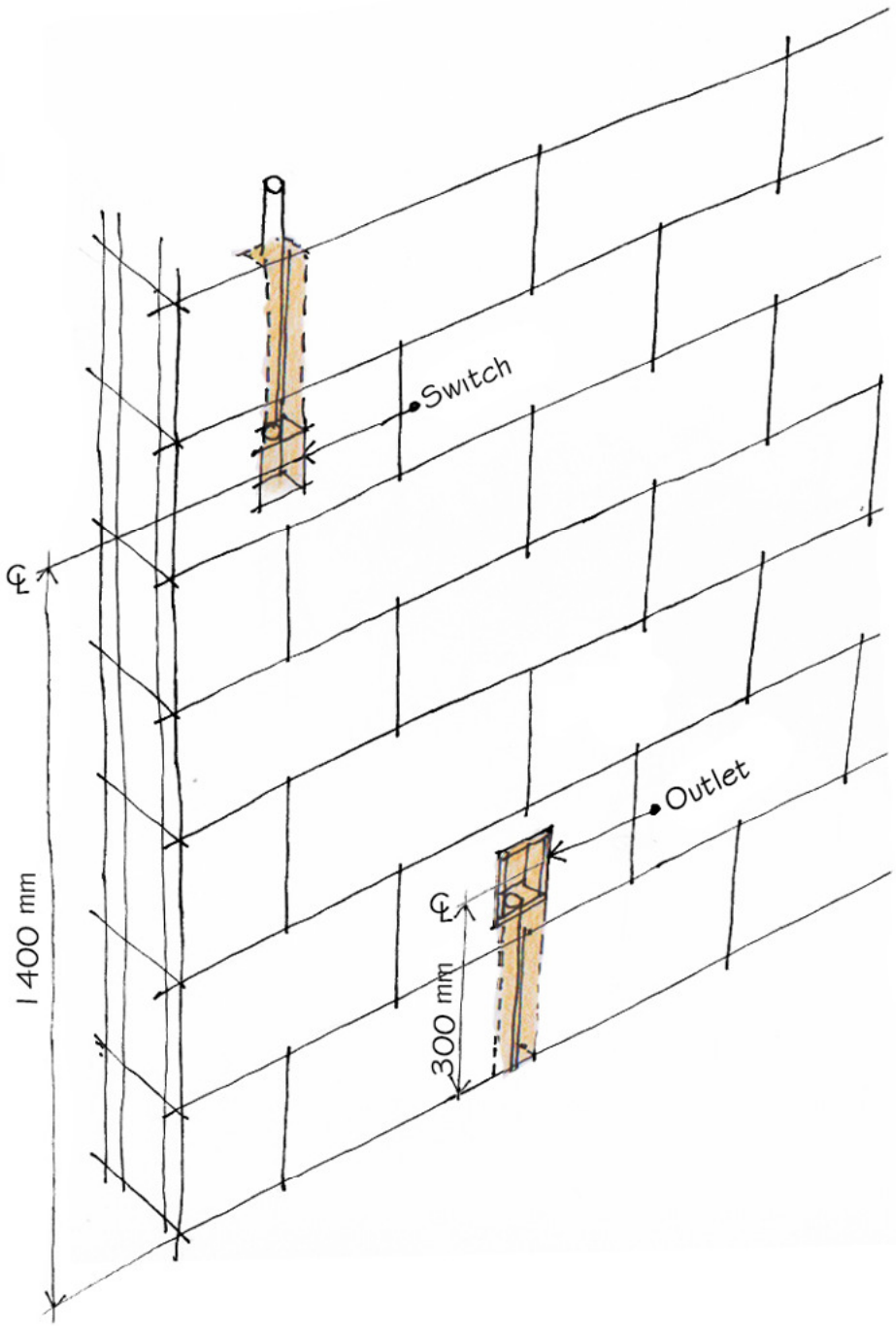
- ☑ fixed
- ☑ oiled
- ☑ cleaned
- ☑ dried of any standing water.

Make sure that steel reinforcement is properly spaced from the formwork.

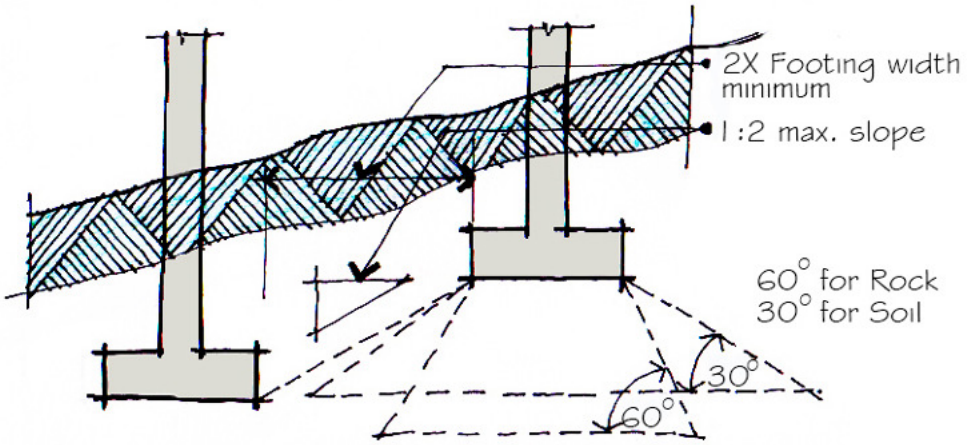


Concrete Column Compaction

ROUGH-INS (ELECTRICAL)

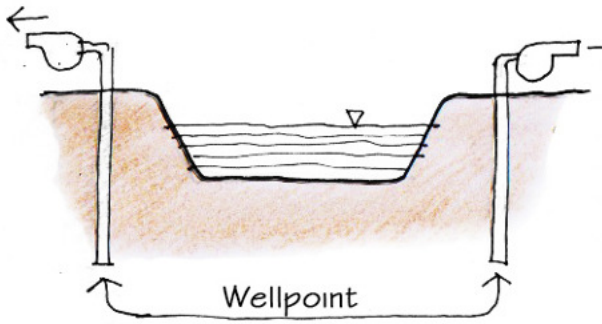


FOUNDATION ON SLOPING TERRAIN



DEWATERING

Use of Perforated Tube

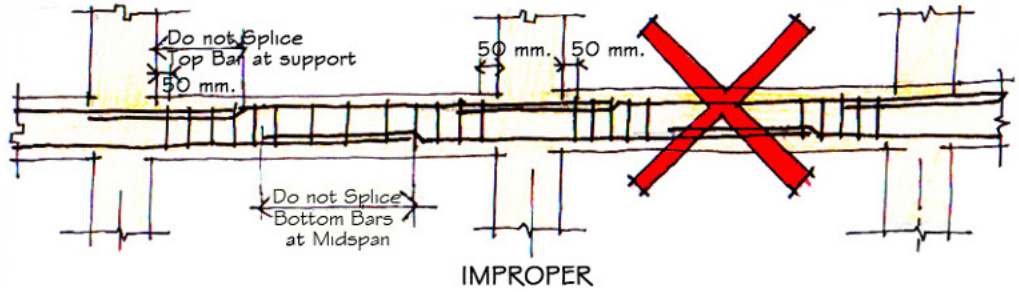


A perforated tube is driven into the ground to collect water from the area so that it could be pumped out.

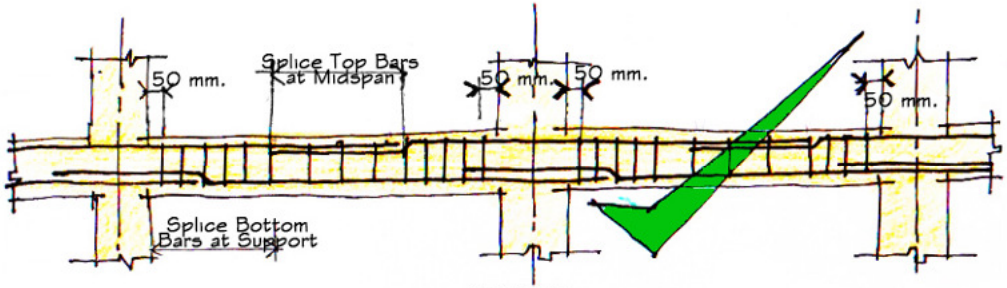
REBAR WORKS

Splice Location for Beams

FOR CONTINOUS BEAMS

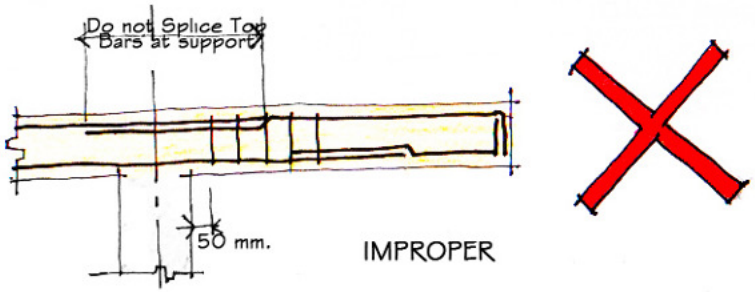


IMPROPER

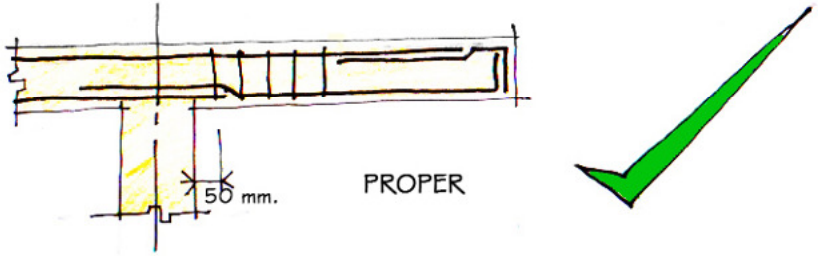


PROPER

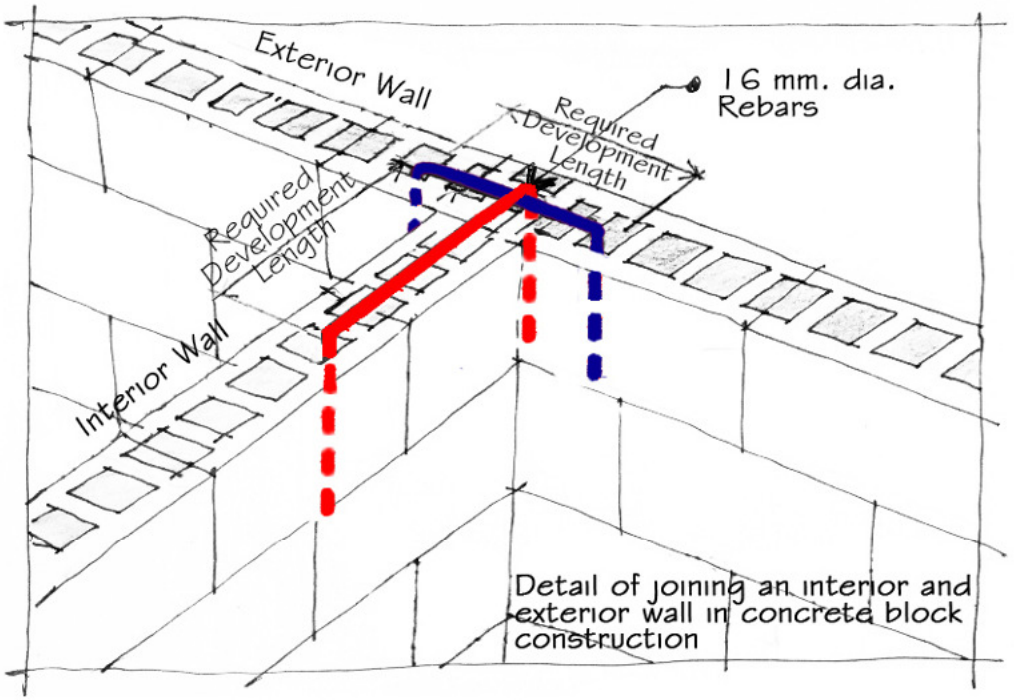
FOR CANTILEVER BEAMS

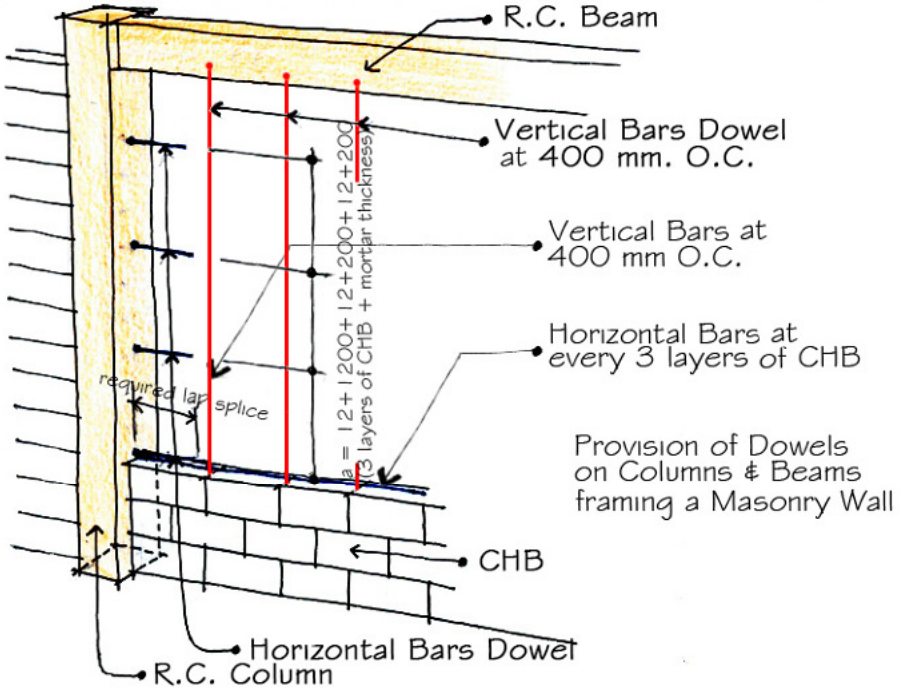


IMPROPER

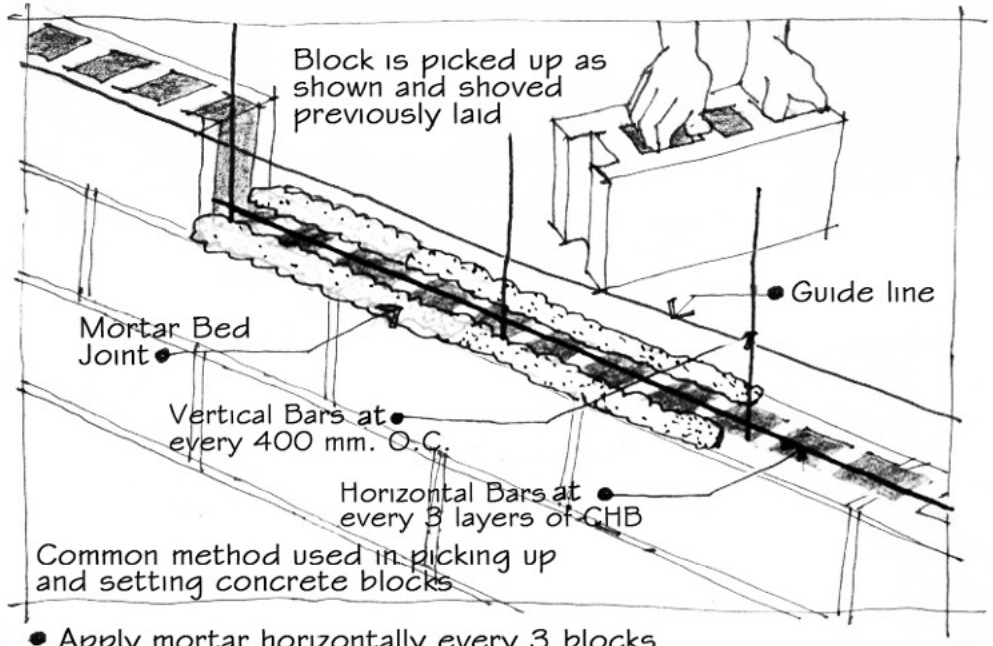


PROPER

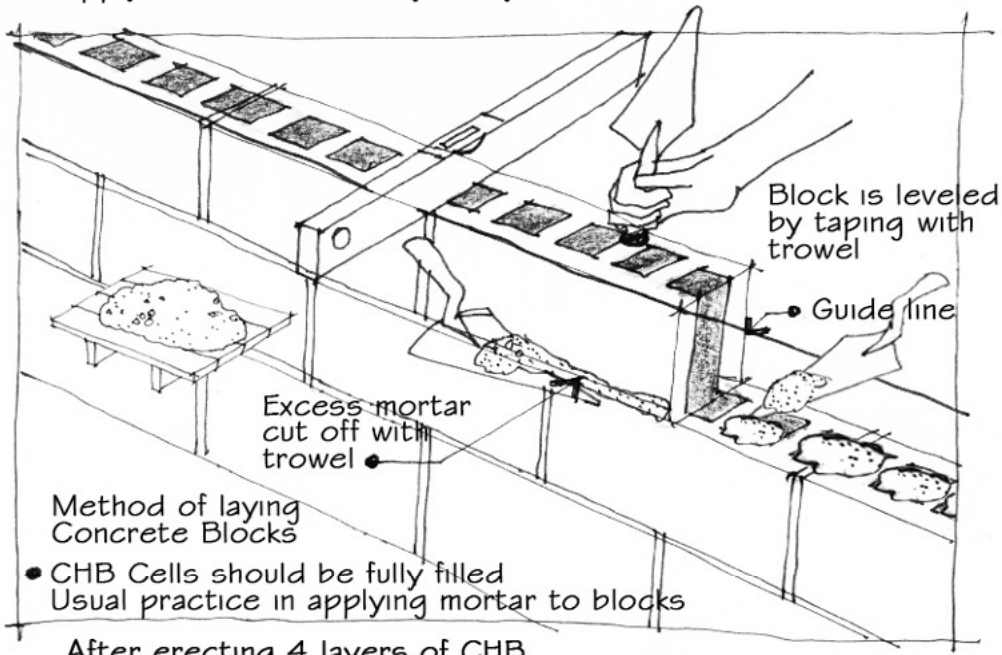




MASONRY WORKS



- Apply mortar horizontally every 3 blocks

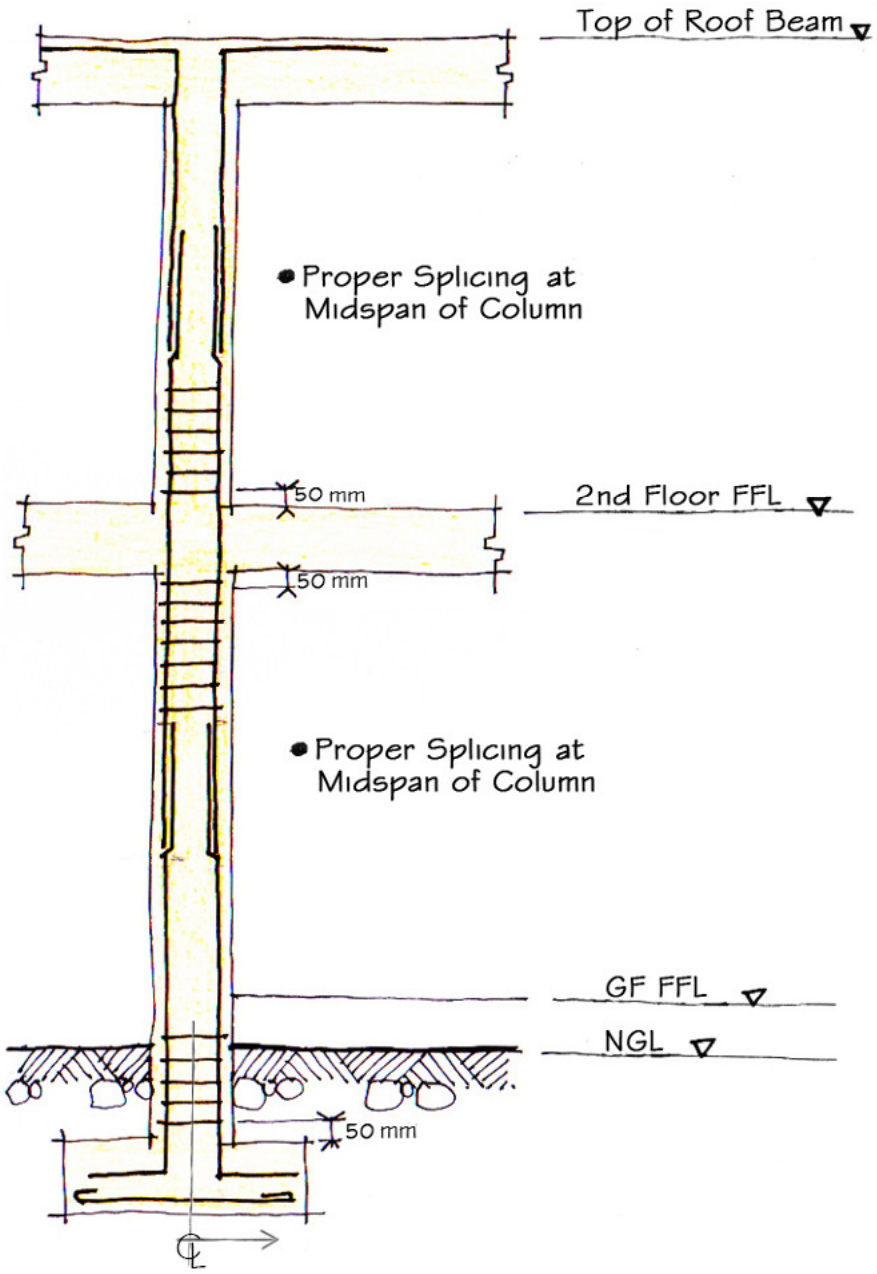


- CHB Cells should be fully filled Usual practice in applying mortar to blocks

After erecting 4 layers of CHB

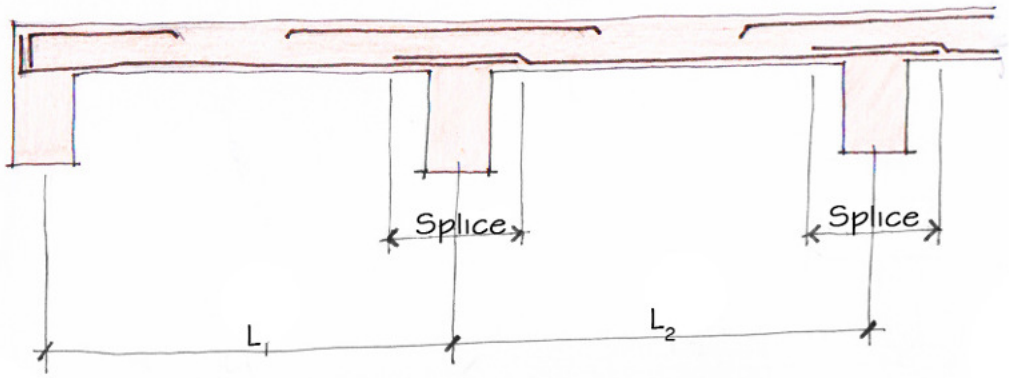
- Observe 3-4 hours interval before proceeding with the next layers of CHB

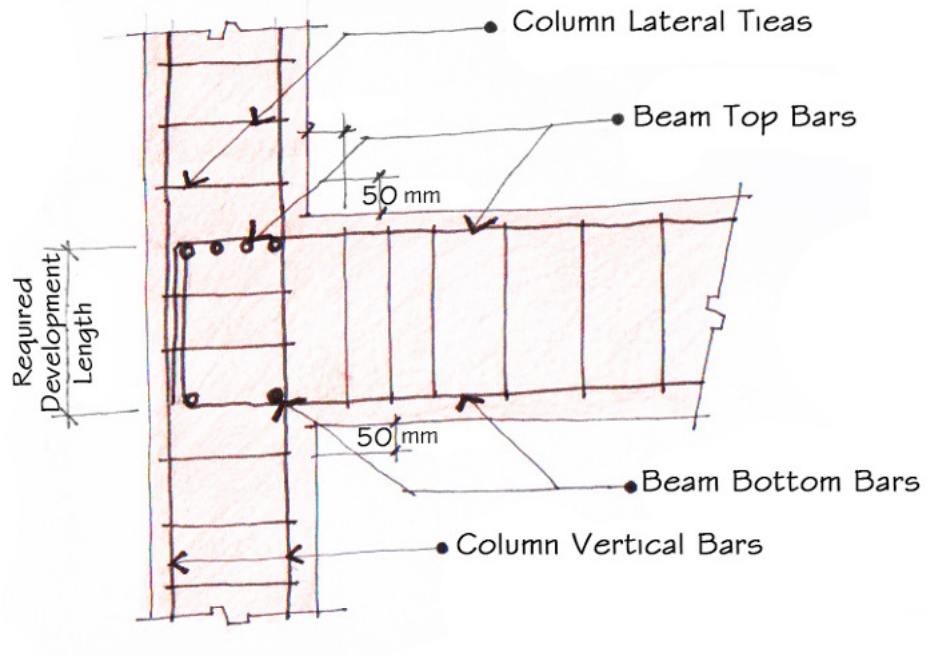
Splice Location for Columns



Splice Location on Suspended Slab

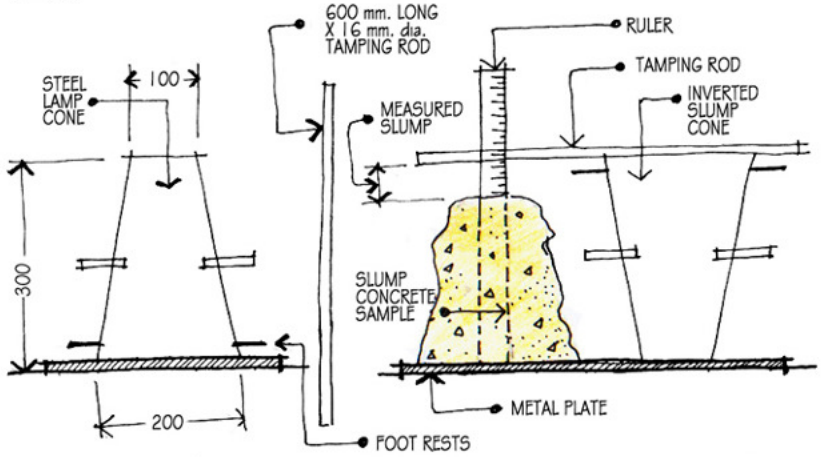
* Bottom bar splices to be located at supports





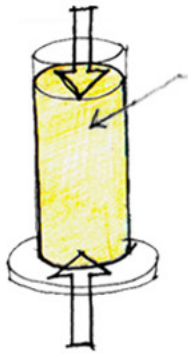
BEAM TO COLUMN CONNECTION DETAIL

SLUMP TEST



The slump cone is filled to a quarter depth and tamped 25 times- filling and tamping is repeated three more times until the cone is full and the top smoothed off. The cone is removed and the slump measured, for consistent mixes, the slump should remain the same for all samples tested. Usual specification is 50 mm or 75 mm slump.

ALLOWABLE SLUMP FOR VARIOUS CONCRETE APPLICATIONS		
TYPES OF CONSTRUCTION	SLUMP (mm)	
	MAX.	MIN.
Reinforced Foundation Walls and Footings	100	50
Reinforced Slabs, Beams and Walls	125	50
Reinforced Columns	125	75
Unreinforced Footings, Caissons, and Substructure Walls	75	25



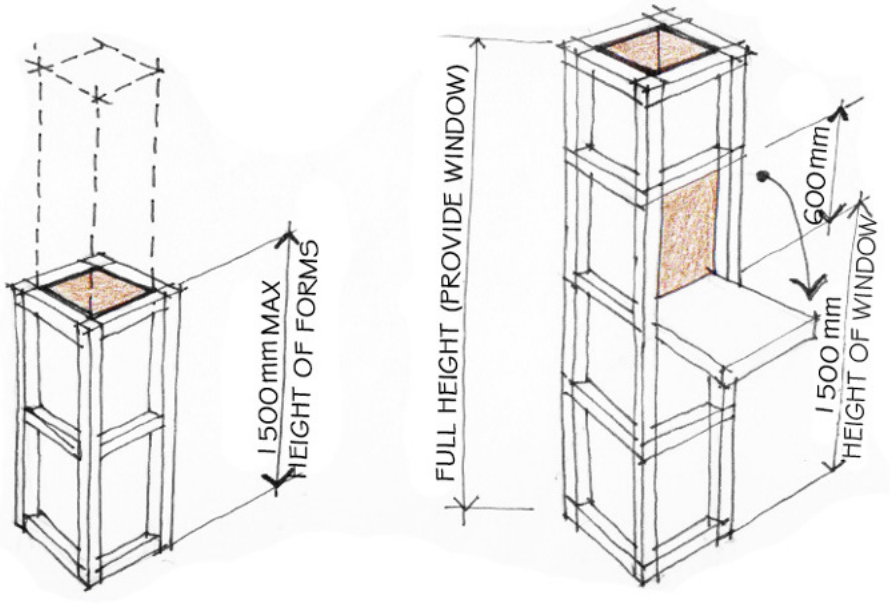
Compression Test

- Provide five (5) cylinders per delivery of truck on site. These cylinders shall be tested on the 7th day, 14th day, 28th day, and the remaining two (2) would be spares in case that the concrete was mixed using bagger.

* Minimum of three samples should be tested regardless of volume of concrete.

Removal of Forms and Concrete Pouring of Columns

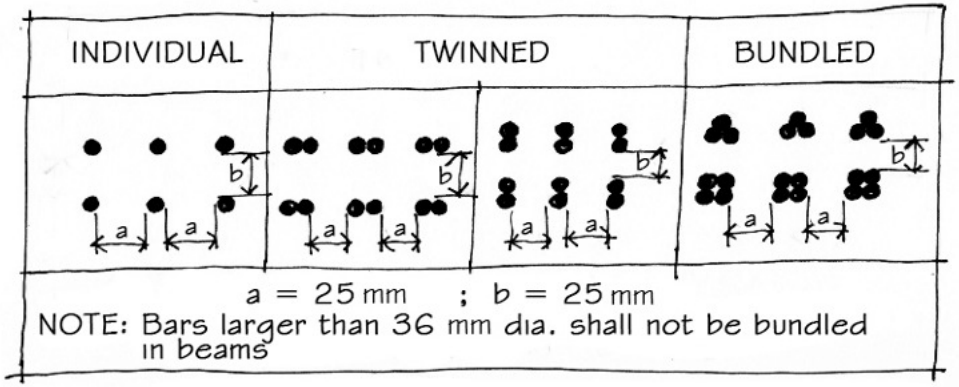
REMOVAL OF FORMS AND SHORING	
ITEM	DURATION
Foundation	24 hrs.
Suspended Slab except when Aditional loads are imposed	8 days
Suspended Slab	14 days
Beams	14 days
Columns (sideforms)	7 days
Walls (sideforms)	7 days



Maximum height of placing concrete mixture on the form shall be 1,500 mm.

Spacing and Arrangement of Bars

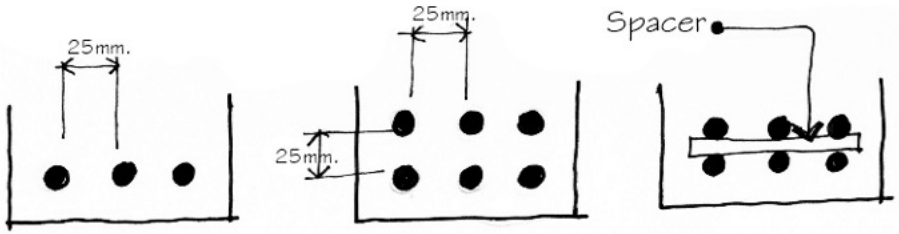
SPACING



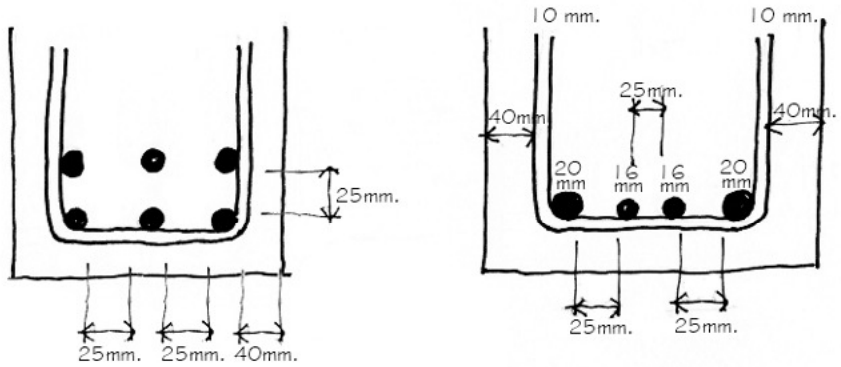
a = 25 mm ; b = 25 mm

NOTE: Bars larger than 36 mm dia. shall not be bundled in beams

ARRANGEMENT (minimum clear distance to guaranty smooth flow of aggregates in the concrete mixture to pass through reinforcing bars).

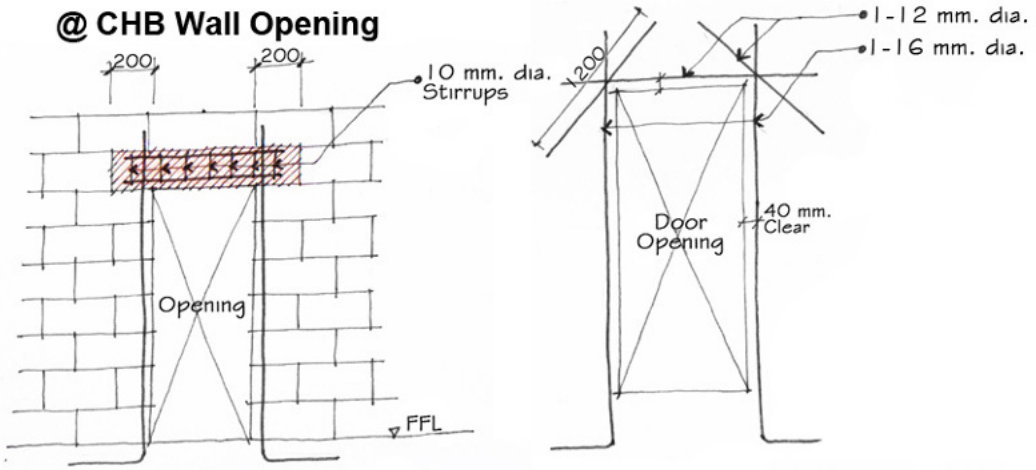


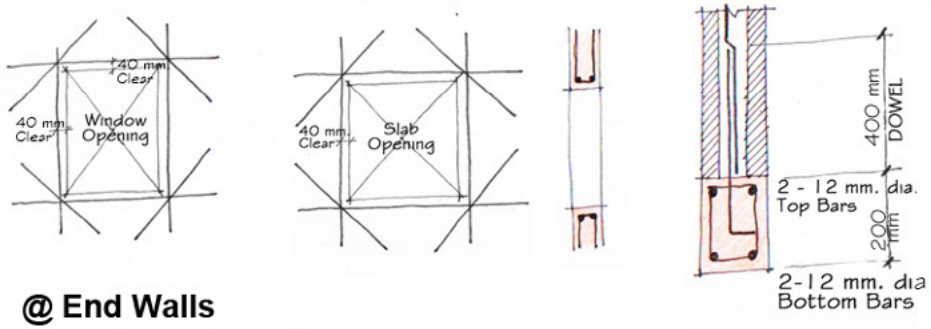
Allow concrete mixture to flow through reinforcing bars.



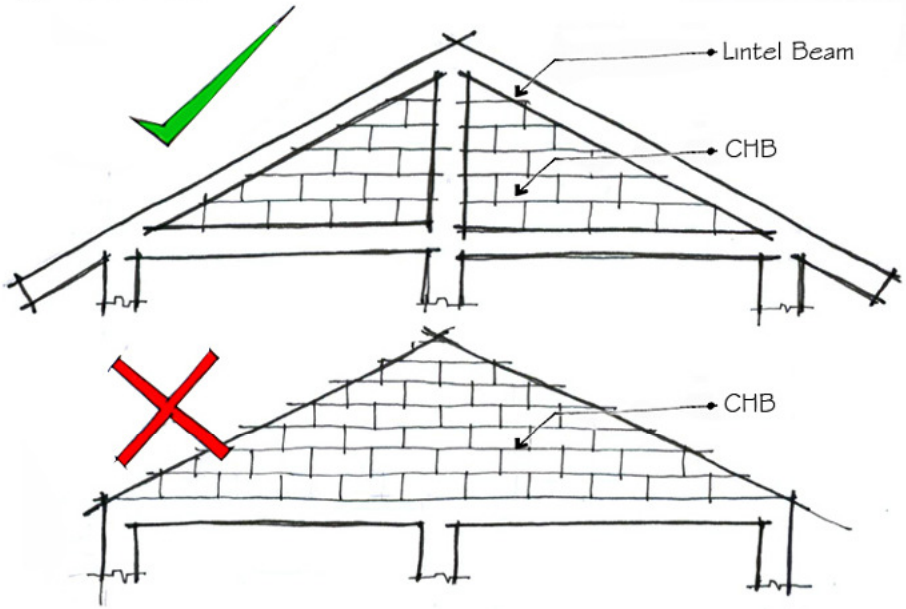
Lintel Beam

@ CHB Wall Opening





@ End Walls



CONCRETE WORKS

Concrete Proportion for different types of Structural Members

TYPE OF CONSTRUCTION	CONCRETE PROPORTION
Footings Beams Columns	1 - Bag Cement 2 cu. ft. Sand 4 cu. ft. Gravel
Floor Slabs Ramps	1 - Bag Cement 2 1/2 cu. ft.Sand 5 cu. ft. Gravel
Filler Mortar & Plastering for CHB wall	1 Bag Cement 3 cu. ft. Sand

Approximate Relative Strength of concrete as affected by type of cement

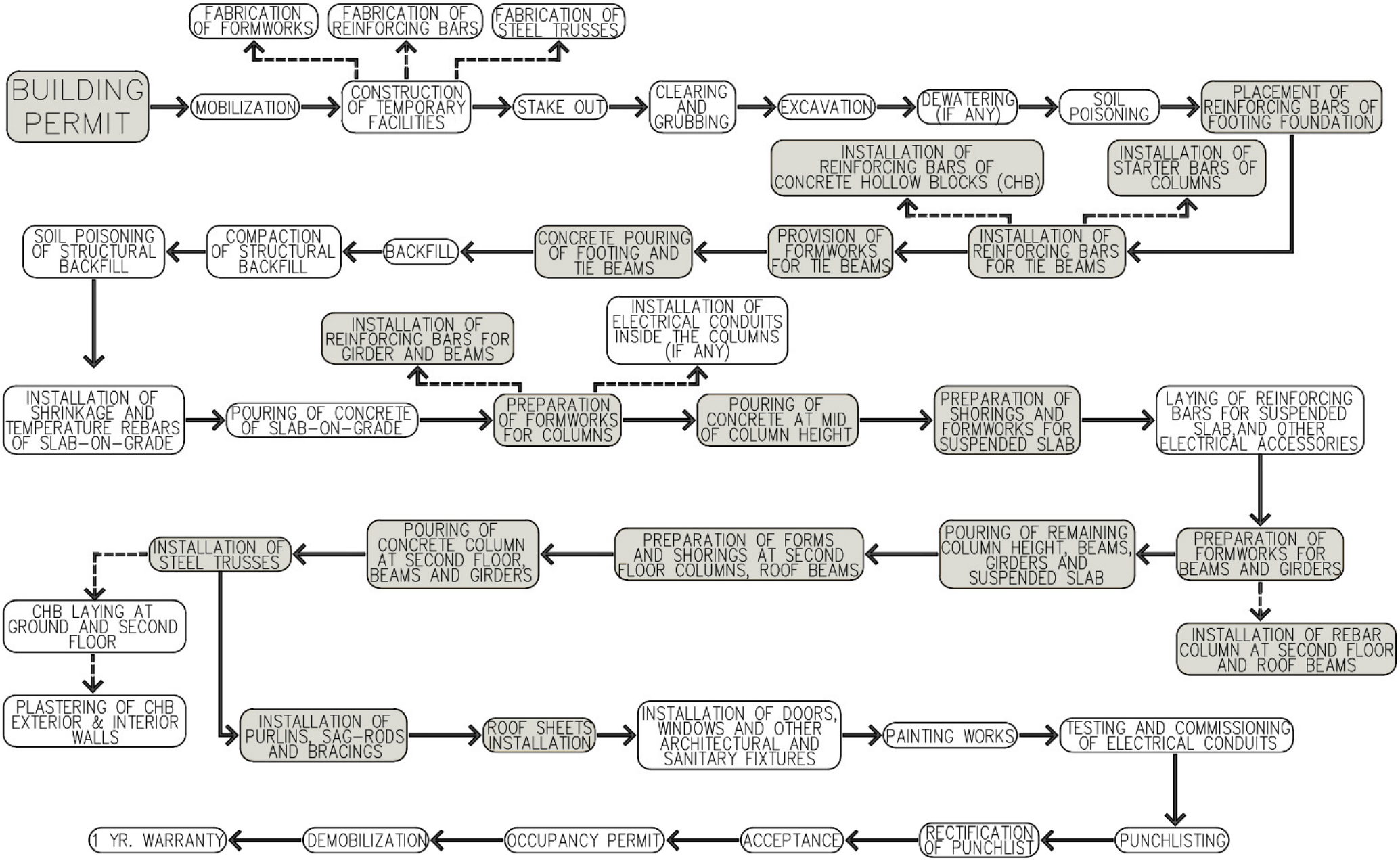
Type of Portland Cement	COMPRESSIVE STRENGTH IN TERMS OF PERCENTAGE			
ASTM	1 day	7 days	28 days	3 mos.
I	100%	100%	100%	100%
II	75%	85%	90%	100%
III	190%	120%	110%	100%
IV	55%	55%	75%	100%
V	65%	75%	85%	100%

ASTM I: General Purpose Cement
ASTM II: Cement for Moderate Sulfate Attack
ASTM III: High-early Strength Cement
ASTM IV: Slow Curing Cement
ASTM V: Cement for Severe Sulfate Attack

Cement/ Sand ratio to achieve 500 PSI masonry block strength

1:6 = 25 pcs. - 150 X 200 X 400 CHB
1:6 = 30 pcs. - 100 X 200 X 400 CHB

SAMPLE FLOW OF CONSTRUCTION ACTIVITIES FOR A 2- STOREY STRUCTURE



TO BE DETACHED

TO BE DETACHED