“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!

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

IN COOPERATION WITH:
MOHR & P.A. ASSOCIATES INC.
Acknowledgements:

- National Structural Code of the Philippines (NSCP), version 8th; ASEP
- Masonry and Builders Library volume 1 (revised edition) by Louis M. Dezetell, 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, Hemi 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.
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. SINGSION
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.

- Hard Hat
- Goggles
- High Visibility Vest
- Gloves
- Boots
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.

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.
Laying Out

In laying out the placement for the J-Bolt, make sure that it will be aligned 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).

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### SAMPLING & TESTING REQUIREMENTS OF BASIC MATERIALS:

<table>
<thead>
<tr>
<th>TEST</th>
<th>FREQUENCY OF TEST</th>
<th>NO. OF SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. WATER</td>
<td>1. Quality Test (PH Level)</td>
<td>one on each source</td>
</tr>
<tr>
<td>B. CONCRETE MASONRY UNIT (Required Units)</td>
<td>1. Absorption Test</td>
<td>10 pcs.</td>
</tr>
<tr>
<td></td>
<td>2. Compressive Test</td>
<td>10 pcs.</td>
</tr>
<tr>
<td>C. CONCRETE</td>
<td>1. Trial Mix (For cases where ready mix is to be used)</td>
<td>on plant every delivery</td>
</tr>
<tr>
<td></td>
<td>2. Slump Test</td>
<td>every delivery</td>
</tr>
<tr>
<td></td>
<td>3. Temperature Test</td>
<td>every delivery</td>
</tr>
<tr>
<td></td>
<td>4. Compressive Test</td>
<td></td>
</tr>
<tr>
<td>D. REINFORCING BARS</td>
<td>1. TENSILE TEST</td>
<td>1 for every 10,000 kgs., or fraction thereof for each size</td>
</tr>
<tr>
<td></td>
<td>1.1 Chemical Composition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 Mechanical Composition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 Bending</td>
<td></td>
</tr>
<tr>
<td>E. FINE AGGREGATES</td>
<td>1. Sieve Analysis</td>
<td>1 per 75m³ or fraction thereof</td>
</tr>
<tr>
<td></td>
<td>2. Fineness Modulus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Bulk Specific Gravity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Absorption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Mortar Strength Soundness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Organic Impurities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Unit Weight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Percent Clay Lumps</td>
<td></td>
</tr>
<tr>
<td>F. COURSE AGGREGATES</td>
<td>1. Sieve Analysis</td>
<td>1 per 1,500 m³ or fraction thereof</td>
</tr>
<tr>
<td></td>
<td>2. Fineness Modulus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Bulk Specific Gravity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Absorption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Abrasion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Soundness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Unit Weight</td>
<td></td>
</tr>
<tr>
<td>G. CEMENT (10 kgs. per 1,000 bags)</td>
<td>1 for every 2,000 or fraction thereof</td>
<td>3</td>
</tr>
<tr>
<td>H. G.I. SHEETS (Basemetal)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>I. STEEL COMPONENTS (ex. angle bars, C-purlins, etc) (with Mill Certificate)</td>
<td>1 for every 10,000 kgs., or fraction thereof for each size</td>
<td>3 per section</td>
</tr>
</tbody>
</table>

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

ROOFING SHEET INSTALLATION

- Put more J-Bolts on edges of the sheets.
- 2 1/2 Min. Corrugation Overlap
- G.I. Sheets
- 6 mm. dia. J-Bolt
- 5 mm. Channel
- C-Purlins
- Angular Bar (1 1/2x1 1/2x3) with 500 mm. on every Purlins
Lateral Cross Bracing

Steel Truss Erection Guide

Roof Beam Line

Prevailing Wind Direction

ROOFING SHEET INSTALLATION

- C - Purlins
- Roofing Sheets

This applies if not using long-span roofing sheets

Beside Cliffs

6.00m (MIN.) 45°

Beside Power Lines

20.00m

Beside Tall Trees
Cut branches & foliage occasionally as adjacent trees grow over time

School Building

45°
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 and 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.
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 75 mm 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.

Q of Column

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
- dry of any standing water.

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

Submerge vibrator into poured concrete mixture from time to time for short intervals only.

Concrete Column Compaction
ROUGH-INS (ELECTRICAL)

FOUNDATION ON SLOPING TERRAIN

2X Footing width minimum
1:2 max. slope
60° for Rock
30° for Soil

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 CONTINUOUS BEAMS

**IMPROPER**
- Do not Splice Top Bar at support
- Do not Splice Bottom Bars at Midspan

**PROPER**
- Splice Top Bars at Midspan
- Splice Bottom Bars at Support

FOR CANTILEVER BEAMS

**IMPROPER**
- Do not Splice Top Bars at Support

**PROPER**
- 50 mm.
**MASONRY WORKS**

- Block is picked up as shown and shored previously laid
- Mortar Bed Joint
- Vertical Bars at every 400 mm O.C.
- Horizontal Bars at every 3 layers of CHB
- Common method used in picking up and setting concrete blocks
- Apply mortar horizontally every 3 blocks
- Block is leveled by taping with trowel
- Excess mortar cut off with trowel
- Method of laying Concrete 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**

- Top of Roof Beam
- Proper Splicing at Midspan of Column
- 2nd Floor FFL
- Proper Splicing at Midspan of Column
- GF FFL
- NGL
Splice Location on Suspended Slab

- Bottom bar splices to be located at supports

![Splice Diagram]

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.

<table>
<thead>
<tr>
<th>TYPES OF CONSTRUCTION</th>
<th>ALLOWABLE SLUMP (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Foundation Walls and Footings</td>
<td>MAX. 100</td>
</tr>
<tr>
<td></td>
<td>MIN. 50</td>
</tr>
<tr>
<td>Reinforced Slabs, Beams and Wails</td>
<td>MAX. 125</td>
</tr>
<tr>
<td></td>
<td>MIN. 50</td>
</tr>
<tr>
<td>Reinforced Columns</td>
<td>MAX. 125</td>
</tr>
<tr>
<td></td>
<td>MIN. 75</td>
</tr>
<tr>
<td>Unreinforced Footings, Caissons, and Substructure Walls</td>
<td>MAX. 75</td>
</tr>
<tr>
<td></td>
<td>MIN. 25</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>REMOVE OF FORMS AND SHORING</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>24 hrs.</td>
</tr>
<tr>
<td>Suspended Slab except when additional loads are imposed</td>
<td>8 days</td>
</tr>
<tr>
<td>Suspended Slab</td>
<td>14 days</td>
</tr>
<tr>
<td>Beams</td>
<td>14 days</td>
</tr>
<tr>
<td>Columns (sideforms)</td>
<td>7 days</td>
</tr>
<tr>
<td>Walls (sideforms)</td>
<td>7 days</td>
</tr>
</tbody>
</table>

Spacing and Arrangement of Bars

Spacing

<table>
<thead>
<tr>
<th>INDIVIDUAL</th>
<th>TWINNED</th>
<th>BUNDLED</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Spacing Diagram" /></td>
<td><img src="image" alt="Spacing Diagram" /></td>
<td><img src="image" alt="Spacing Diagram" /></td>
</tr>
</tbody>
</table>

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.
CONCRETE WORKS
Concrete Proportion for different types of Structural Members

<table>
<thead>
<tr>
<th>TYPE OF CONSTRUCTION</th>
<th>CONCRETE PROPORTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footings Beams Columns</td>
<td>1 Bag Cement + 2 cu. ft. Sand + 4 cu. ft. Gravel</td>
</tr>
<tr>
<td>Floor Slabs Ramps</td>
<td>2 1/2 cu. ft. Sand + 1 Bag Cement + 5 cu. ft. Gravel</td>
</tr>
<tr>
<td>Filler Mortar &amp; Plastering for CHB wall</td>
<td>1 Bag Cement + 3 cu. ft. Sand</td>
</tr>
</tbody>
</table>

Approximate Relative Strength of concrete as affected by type of cement

<table>
<thead>
<tr>
<th>Type of Portland Cement</th>
<th>COMPRESSION STRENGTH IN TERMS OF PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 day</td>
</tr>
<tr>
<td>ASTM I: General Purpose Cement</td>
<td>100%</td>
</tr>
<tr>
<td>ASTM II: Cement for Moderate Sulfate Attack</td>
<td>75%</td>
</tr>
<tr>
<td>ASTM III: High-early Strength Cement</td>
<td>90%</td>
</tr>
<tr>
<td>ASTM IV: Slow Curing Cement</td>
<td>55%</td>
</tr>
<tr>
<td>ASTM V: Cement for Severe Sulfate Attack</td>
<td>65%</td>
</tr>
</tbody>
</table>

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

BUILDING PERMIT ➔ MOBILIZATION ➔ CONSTRUCTION OF TEMPORARY FACILITIES ➔ STAKE OUT ➔ CLEARING AND GRUBBING ➔ EXCAVATION ➔ DEWATERING (IF ANY) ➔ SOIL POISONING ➔ INSTALLATION OF REINFORCING BARS OF FOOTING FOUNDATION

SOIL POISONING OF STRUCTURAL BACKFILL ➔ COMPACTED STRUCTURAL BACKFILL ➔ BACKFILL ➔ CONCRETE POURING AND TIE BEAMS ➔ INSTALLATION OF REINFORTNCING BARS FOR TIE BEAMS ➔ INSTALLATION OF REINFORCING BARS FOR TIE BEAMS

INSTALLATION OF SHRINKAGE AND TEMPERATURE REBARS OF SLAB-ON-GRADE ➔ POURING OF CONCRETE OF SLAB-ON-GRADE ➔ PREPARATION OF FORMWORKS FOR COLUMNS ➔ POURING OF CONCRETE AT MID OF COLUMN HEIGHT ➔ PREPARATION OF SHORINGS AND FORMWORKS FOR SUSPENDED SLAB ➔ LAYING OF REINFORCING BARS FOR SUSPENDED SLAB AND OTHER ELECTRICAL ACCESSORIES

INSTALLATION OF STEEL TRUSSES ➔ POURING OF CONCRETE COLUMN AT SECOND FLOOR BEAMS AND GIRDERS ➔ PREPARATION OF FORMS AND SHORINGS AT SECOND FLOOR COLUMNS, ROOF BEAMS ➔ POURING OF REMAINING COLUMN HEIGHT BEAMS, GIRDERS AND SUSPENDED SLAB ➔ PREPARATION OF FORMWORKS FOR BEAMS AND GIRDERS

CHB LAYING AT GROUND AND SECOND FLOOR ➔ PLASTERING OF CHB EXTERIOR & INTERIOR WALLS ➔ INSTALLATION OF PURLINS, SAG-RODS AND BRACINGS ➔ ROOF SHEETS INSTALLATION ➔ INSTALLATION OF DOORS, WINDOWS AND OTHER ARCHITECTURAL AND SANITARY FIXTURES ➔ PAINTING WORKS ➔ TESTING AND COMMISSIONING OF ELECTRICAL CONDUITS

1 YR. WARRANTY ➔ DEMOBILIZATION ➔ OCCUPANCY PERMIT ➔ ACCEPTANCE ➔ RECTIFICATION OF PUNCHLIST ➔ PUNCHLISTING