2.1 TOOLS

Tape measure
Chalk line
String line
Hammer
Hand saw
Reciprocating saw
Keyhole saw
Table saw
48" hand level
Framing square
Various drill / screw bits
Pliers
Loop tie twister
Cordless drill
Foam dispensing gun*
Hot knife
Utility knife
Laser level / transit
Concrete vibrator*
Cut off saw
Stepladder
Various shovels
Rubber mallet
Bolt cutters
Pruning saw
Pruning shears
Tin snips
Electric chainsaw
Rebar bender / cutter*
Generator
Extension cords
Hammer drill
Concrete trowels
NUDURA® alignment / scaffolding system*

*Items offered through NUDURA® Corporation

The tools listed above are recommended for the installation of NUDURA® Technology. Although not all of the listed tools are required for most projects, the well-equipped installer will surely make use of them all, as he encounters various construction details.

2.2 MATERIALS

- NUDURA® form units*
- Reinforcing steel
- Tie wire / zip ties
- Rebar ties
- Scaffold planks
- Nails & screws
- Window and door buck material
- Anchor bolts
- Floor connection system
- Various mechanical sleeves
- Lumber as required
- Low expansion spray foam*
- Fiber tape*
- Protection tape for top of wall*
- Concrete
- Waterproofing membrane*
- Parging materials and mesh*
- NUDURA® Easy Buck*
- Spray foam gun cleaner*
- Multi-Purpose Anchor Hanger System*

*Items offered through NUDURA® Corporation

The material list above is a typical list to be used as a checklist. Other material may be required depending on the complexity of the project.

2.3 EXCAVATION AND LAYOUT

Most foundations involve the excavation of either soil or rock to some required depth. Topsoil and organic matter are to be removed in all areas under a building.

The bank of the excavation must be placed far enough away from the projected location of the exterior of the foundation to allow safe access for work which will need to be performed on the exterior of the foundation wall before and after the placement of the concrete.

The excavated site should be kept free of organic materials, water accumulation and protected from freezing during the construction period.

It is important to provide set back stakes and batter boards. Batter boards provide the footprint of the building (or sections thereof) after excavation.

Various methods may be used to ensure the building layout is accurate.

- Pythagorean Theorem $A^2 + B^2 = C^2$
- 3-4-5 (or multiples thereof) Right Angle Triangle Principle
- Corner-to-Corner Equal Distance method
- Utilize your local surveyor

2.4 FOOTINGS OR SLABS

- Footings are designed to transfer and distribute the loads applied from the building structure without exceeding the safe load bearing capacity of the soil or rock on which they bear.
- IMPORTANT! The footing should be placed on undisturbed native soil or a compacted granular base as per local code requirements. The top of the footing or slab should be levelled to a tolerance of ± 1/4" (6mm). Staying within this tolerance will save a lot of additional work when placing the first and second courses.
- Step footings when required, should have vertical increments equal to the form unit height of 18" (457mm) where possible . A half step can effectively be used at the lower level. The form unit will be cut in half and installed with the interlocks facing upwards. When using this procedure the first step increment should be 8 1/2" (216mm) to allow for the projecting interlock at the base of the second courses.
- At this time, it is not possible to respect the step increments of 18" (457mm) or 8 1/2" (216mm) at the first step. Special consideration should be given to have height differentials of a multiple of number of courses (see coursing chart – Section 5).
- Slabs that perform the function of the footing must conform to local building codes.
- Vertical reinforcement dowels provide lateral support at the base of the wall. The dowels must be placed in the footing or slab edge at the center of the monolithic concrete wall.
- Footings or slabs must conform with all local codes, regulations and standards.

2.5 MATERIAL PLACEMENT

Always perform or check the layout prior to placing tools and material in the work area.

At most construction sites it is best to work from inside the perimeter walls. All materials and tools required for the assembly of the wall should be placed inside the footing area or on the slab.

Special care should be taken to have form units accessible where needed while maintaining the 6' (183cm) clear distance around the perimeter to allow room for the alignment system.

A clean, accessible work site will prove to be beneficial both in terms of production and safety.

TOOLS AND MATERIALS REQUIRED IN WORK AREA

TOOLS

Tape measure
Pliers
Rubber mallet
Chalk line
Loop tie twister
Bolt cutters
String line
Cordless drill
Pruning saw
Hammer
Foam dispensing gun*
Pruning shears
Hand saw
Hot knife
Tin snips
Reciprocating saw
Utility knife
Electric chainsaw
Keyhole saw
Laser level / transit
Rebar bender / cutter*
Table saw
Concrete vibrator*
Generator
48" hand level
Cut off saw
Extension cords
Framing square
Stepladder
Hammer drill
Various drill / screw bits
Various shovels
Concrete trowels
NUDURA® alignment / scaffolding system*

MATERIALS

NUDURA® form units*
Reinforcing steel
Tie wire / zip ties
Rebar ties
Scaffold planks
Nails & screws
Window and door buck material
Anchor bolts
Floor connection system
Various mechanical sleeves
Lumber as required
Low expansion spray foam*
Fiber tape*
Protection tape for top of wall*
Concrete
Waterproofing membrane*
Parging materials and mesh*
NUDURA® Easy Buck*
Spray foam gun cleaner*
Multi-Purpose Anchor Hanger System*

*Items offered through NUDURA® Corporation

2.6 1ST COURSE FORM UNIT PLACEMENT

The footing or slab area, where the form units are to be installed, should be free of dirt and debris. Special care should be taken during the installation of the form units to keep the wall cavity free of foreign material.

Extra time spent to establish an effective layout/pattern for the form units in the first course will save time on all the successive courses. This can prove to be a good investment of time, as it will save unnecessary cutting of form units and requirement for form support.

It is recommended to start on the longest wall at each corner and work towards the center. Establish a pattern around the perimeter of the building. This practice will result in any cut being close to the center of the wall. It will ensure the webs will always be lined up and locked together making it easier for the trades that will follow to attach other building materials to the fastening strips. Additionally, having the webs line up will virtually eliminate compression during concrete pour.

Ensure the form units are tight end-to-end to maintain proper dimensions.

The form unit should be cut on one of the cut lines indented in the EPS. The cut lines must be respected to ensure the foam interlock will continue to mesh. The use of the cut lines will result in an overall building dimension with a maximum tolerance of 1"± (25mm). Special attention must be given to maintain the square of the building when making an adjustment to any wall dimensions. In plan layouts where dimensions are critical to local setback requirements or specific required interior room dimensions, an "off-cut line" (vertical joint) seam is an alternate method of layout. It should be located near the center of the wall length. So long as the off-cut line seam occurs at the same point on all succeeding courses and is supported with wood strapping or fiber tape at each course, there is no concern posed by the vertical stack bond created since the form fastening strips structurally link with each other. It has been found that a 3' (914mm) piece of form lock installed into each course helps to keep the joint in line.

Ideally, by following these rules, there should be no need to cut any corner forms and the 16" (406mm) offset stacking pattern that's established by reverse stacking one corner form over top another will be maintained. Invariably, there will be some plan layouts where wall lengths between corners are so small that either off-cut lines or cutting the corner forms will be necessary. In these cases, additional form support will be required.

2.7 PLACEMENT OF REINFORCING STEEL

The steel reinforcement shall be installed as per the plans and specifications prepared by a qualified designer. The placement of the reinforcement steel shall conform to local standards, regulations or codes having jurisdiction.

The horizontal rebars are installed into the notches provided in the web, allowing easy and secure placement. The horizontal rebars are installed after each course of form units.

It is recommended to alternate the position of the horizontal rebar, from one successive course to another, in order to create a cage for maintaining the alignment of the vertical rebars.

It is typical for the reinforcing steel to be placed on the tension side of the wall below grade and in the center of the wall above grade.

Lap length is usually in the order of 40 times the diameter of the rebar. Lap splices can be contact lap splices (which should be tied), or non-contact lap splices which can be separated up to 1/5 of the lap length (i.e. 1/5 x 40 dia) to a maximum of 6" or 150mm. The rebar does not need to be tied if proper alignment is maintained by the notches in the webs prior and during the placement of concrete.

The vertical reinforcement is installed after all the form units are installed and prior to the placement of concrete. The vertical rebar should be cut to 2" (51mm)below the termination of the pour. If successive storeys are to follow, cold joint dowels should be installed as per the vertical rebar placement. Field experience has proven it is easier to insert dowels after the concrete placement versus working with longer, vertical rebar which interfere with the concrete placement.

STANDARD IMPERIAL REBAR LAP SPLICES

REBAR SIZE (DIAMETER)	#4 (1/2”)	#5 (5/8”)	#6 (3/4”)
LAP LENGTH 40 x REBAR DIAMETER	20”	25"	30"
MAXIMUM SEPARATION 1/5 X LAP LENGTH	4"	5"	6"

* Note: Maximum rebar separation is 6"

METRIC REBAR LAP SPLICES

REBAR SIZE (DIAMETER)	10mm	15mm	20mm
LAP LENGTH 40 x REBAR DIAMETER	400mm or 16” Lap	600mm or 24” Lap	800mm or 32” Lap
MAXIMUM SEPARATION 1/5 X LAP LENGTH	80mm or 3 1/4” Lap	120 or 4 3/4” Lap	150 or 6” Lap

* Note: Maximum rebar separation is 150 mm

Canada CSA A23.1-2-3 and CSA A 438
United States ACI 318 or ACI 332

2.8 2ND COURSE FORM UNIT PLACEMENT

It is recommended to start the second course at the same corner where the first course started. In placing the second course, each corner form unit will be reversed to create an automatic 16" (406mm) offset or "bond" stack with the form units on the first course. Align the units in place and press the form unit firmly downward until the web interlocks "snap-lock" together. After the unit is in place a rubber mallet can be used to ensure that the interlocks are properly engaged.

A minimum of 8" (203mm) staggering of vertical joints should be maintained. If it is not possible the vertical joints will need additional form support. This can consist of sheathing or 1" x 4" (19mm x 89mm) lumber attached to the fastening strips using #10 x 2" (50mm) wood screws.

Immediately after placement of the second course the form should be levelled to account for any uneven footings, (see next section).

To assist in aligning the walls, some contractors may find it beneficial to install "form-lock" in the wall cavity immediately after the second course placement since this course is below most window openings. It has been found that form-lock can be used to minimize deflection of the form units, especially in longer wall lengths. Remember however, that during concrete placement caution should be exercised to ensure that concrete is adequately vibrated to achieve thorough consolidation in the area below the form-lock.

2.9 CORRECTION FOR UNEVEN FOOTINGS

The footing can be checked prior to installation of any form units, but it is best to correct any deficiencies after the first 2 courses of NUDURA® form units are installed. The form will bridge over low areas of the footing and ride on the high points. A laser level can be used to easily detect areas which may cause problems. It is easier to fill in hollow or low areas under the form than cutting the form where footing may be high. Usually the fix for uneven footing will require both shimming and cutting.

2.10 SUCCESSIVE COURSES & ADDITIONAL FORM SUPPORT

Successive courses will follow in the same manner as the first two courses. The first, third and fifth courses should be identical and similarly the second, fourth and sixth course should be identical except for openings and penetrations.

Additional form support may be required to prevent movement of the forms during concrete placement. The following conditions may require additional support:

- More than 2 foam bars beyond the web at a cut end
- Minimum 8" (203mm) stagger is not achieved, or cut is next to a corner
- T-wall to resist concrete pressure
- Tapered form to reinforce the top edge of the tapered side
- Window or door buck near a corner

2.11 WINDOW AND DOOR OPENINGS

Window and door openings can be created using lumber material, EPS end cap with lumber material for the header, or with the NUDURA® Easy Buck, a composite buck system using lumber inserts.

The Rough Opening (RO) dimension is the opening required to install the window or door allowing for adjustment and insulation at the time of installation. It is important to establish if the type of buck being built is "stay-in-place" or to be removed prior to the installation of the window or door buck. The RO in a stay-in-place buck will be the interior dimension of the buck. The stay-in-place buck can provide fastening for the window or door and for moldings and finishing.

1) Wood buck can be constructed using 1" (19mm) or 2" (38mm) dimensional lumber, the same width as the wall thickness.

2) Another method used for wood buck is the insertion of cut or widened lumber, in the cavity of the form to create the required opening. It can be secured in place with expanding foam sealant and temporarily cross braced until concrete has cured.

3) Bucks can also be created using end caps with fastening strip. The head of the buck is usually created with lumber in a similar fashion as for the wood buck. If greater depth is required for the concrete lintel, the buck should be constructed to allow for the removal of the lumber used in the head of the buck. This will result in a concrete lintel 11/2" (38mm) deeper.

4) The buck can also be built using the Easy Buck material. The method consists of a combination of the Easy Buck and 2" (38mm) dimensional lumber. This method is usually a stay-in-place buck.

It is good practice to use 2" x 2" (38mm x 38mm) or 2" x 4" (38mm x 89mm) lumber for the seat of a window buck for ease of concrete placement. Using this practice if the lumber is to stay in place, the concrete is trowelled flush with the lumber in the seat of the buck. Pressure treated lumber may be required in certain applications as per local code requirements.

When the buck material is designed to stay in place and the window or door is to be fastened to it, it is important to provide proper anchorage of the buck to the concrete as per code requirement.

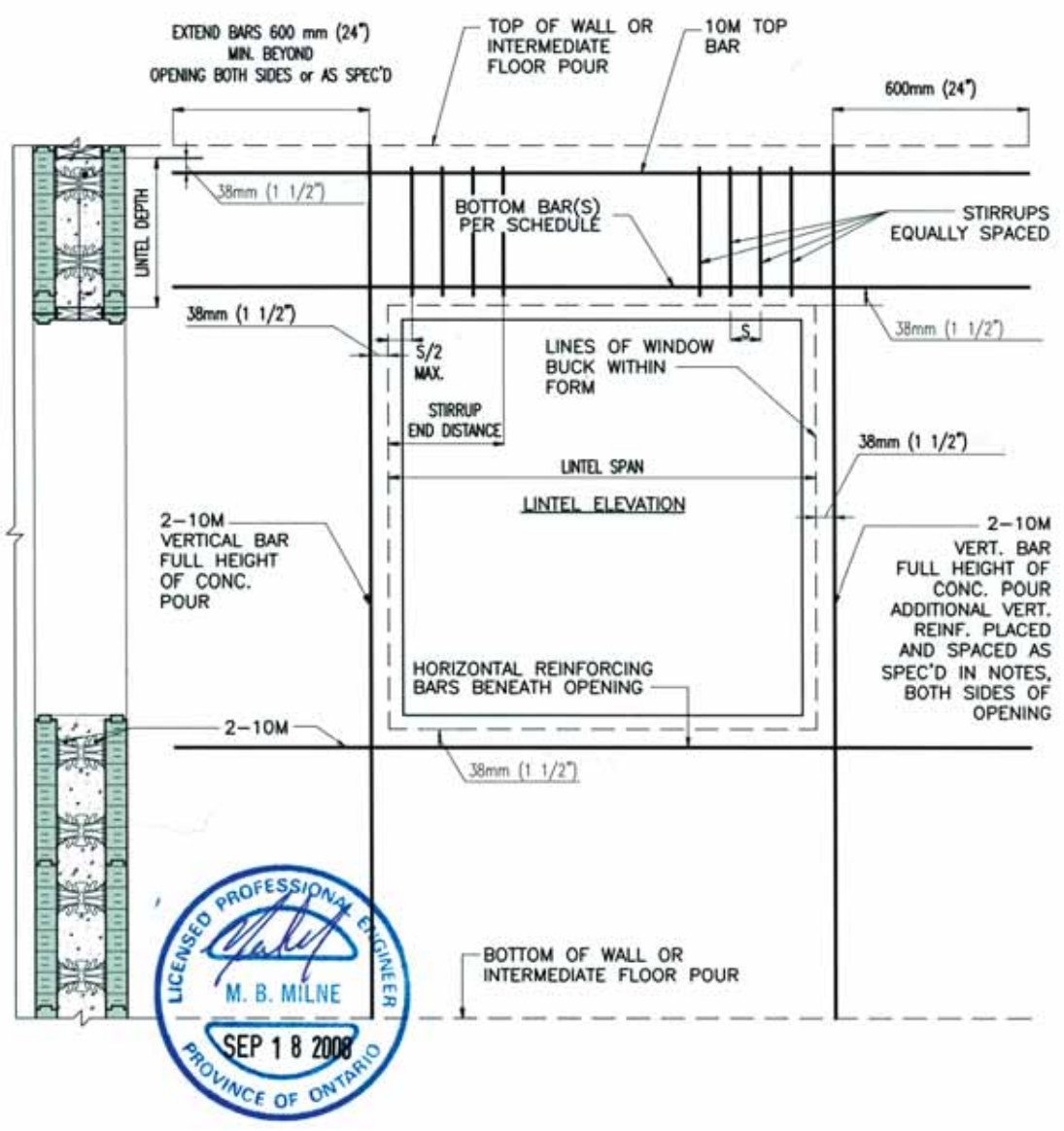
Prior to the concrete placement, all required means of form support must be installed to resist fluid concrete pressures. Any corners 8' (2438mm) or less from an opening will require form support, tying the corner back to the buck. Alternately, exterior bracing could be installed to provide support to the corner forms.

2.12 LINTEL REQUIREMENTS

Lintel reinforcement requirement will vary based on load conditions, depth of lintel, width of opening, concrete strength and wall thickness. NUDURA® Corporation has prepared Lintel Tables for NUDURA® walls as a reference for designers and engineers.

The lintel table can be used to determine the reinforcing steel required in the bottom of the lintel, the requirement for shear stirrups and stirrup spacing. To use the table, the designer must calculate the uniform superimposed load up to 3426 lbs/ft (50 KN/m), for any given width of opening up to 20' (610cm) and lintel depth 9" (229mm) to 24" (610mm) with increments of 3" (76mm) as per the local building code.

The tables have been computed with concrete strength of 3000 psi (20 Mpa).
(See drawing LD and corresponding tables) Appendix E.



2.13 WALL BRACING / ALIGNMENT & SCAFFOLDING SYSTEM

Additional site specific engineering may be required in some case to ensure that the scaffold installation is fully compliant.

The NUDURA® bracing, alignment and scaffold system is designed to provide three functions in one application. The system consists of a vertical channel which is attached to both the form unit and the footing. A No. 10 coarse thread screw is used to attach the channel to the form unit. One screw per course is usually satisfactory. It is the responsibility of the contractor to adequately anchor the base of the channel to the footing or slab. Clevis pins or bolts 1/2" (13mm) in diameter of A307 material or better are then installed to support the scaffold bracket and attach the diagonal pole to the box channel.

The base of the diagonal pole is secured using a drift pin or appropriate fastener, depending on the surface that the base is being attached to. Anchorage of all components must be in accordance with local safety standards.

Prior to securing the base, the installer should verify that the diagonal pole threads are exposed by at least 6" (152mm) and that the box channel is plumb or leaning slightly against the diagonal pole.

On an average, 1 brace per 6' (1.83m) of wall plus 1 brace for each corner will be required.

Once concrete has cured to sufficient strength, the NUDURA® bracing, alignment and scaffold system can be removed. Wind bracing may be required on tall walls if no lateral support in the form of a floor or roof system has been installed. Note: For below grade applications, some local codes may dictate that floor installations must be completed prior to completion of any back fill against the wall.

It is good practice to center the threads on the diagonal pole at the time of removal.

2.14 INSTALLATION OF SERVICE PENETRATIONS

Commonly required service penetrations may include any or all of the following items:

- water line
- sanitary sewer line
- storm sewer line
- electrical service
- oil tank
- gas line
- chimney
- electrical fixtures and receptacles
- audio & video service
- hose bibs
- hot water tank vent
- exhaust fan vent
- range hood vent
- dryer vent
- HRV vents
- A/C lines
- spares

The installation of a service penetration is a simple procedure. The installer will need to cut a hole in the EPS using a keyhole saw or hot knife for the sleeve as required. It is best not to cut into the web as this will weaken the form. Should it be necessary to cut a portion of the web, form support around the opening may be necessary.

The proper method requires placing the correct size of conduit to be used in the installation. The installer should make sure the conduit is long enough to permit the use of couplers or fittings at each end.

2.15 PRE-CONCRETE PLACEMENT CHECKLIST

- ❑ Is wall built according to drawing?
- ❑ Has all additional support been installed?
- ❑ Is rebar installed per plans or as specified in the correct location?
- ❑ Is lintel rebar installed correctly?
- ❑ Is NUDURA® alignment system installed correctly?
- ❑ Have all openings been installed and in correct location?
- ❑ Do you have correct size of rough openings?
- ❑ Has proper anchorage for buck material been used?
- ❑ Construction joint reinforcement or protection for protruding rebar?
- ❑ Have all service penetrations been installed?
- ❑ Have all T Form units been braced?
- ❑ Have all beam pockets been installed and in correct location?
- ❑ Have all string lines been installed around perimeter of building?
- ❑ Have walls been straightened?
- ❑ Has all interlock been protected?
- ❑ Is there adequate support on gable ended walls?
- ❑ Are roof or floor connection anchors on site?
- ❑ Do you have a tool for consolidation? (concrete vibrator)
- ❑ Are there back up materials in case of blowout?
- ❑ Is the concrete order as per code or as specified?
- ❑ Is there enough room for concrete pump or trucks to maneuver on site?
- ❑ Has operator been made aware of all trees, roof overhangs and power wires?
- ❑ If pouring with a pump are there reducers along with a double 90º elbow?
- ❑ If pouring by other means is there enough room to maneuver around site?

TOOLS FOR CONCRETE PLACEMENT

- ❑ Magnesium trowels
- ❑ Home made trowel to recess plate
- ❑ Concrete vibrator
- ❑ Laser level
- ❑ Hand level
- ❑ Ladders
- ❑ Wheel barrows
- ❑ Normal hand tools
- ❑ Cordless drill and screws
- ❑ 4' (1.22m) and 8' (2.44m) straight edge
- ❑ Material for supplementary bracing and straightening
- ❑ Hand shovel

2.16 CONCRETE SPECIFICATION

The concrete mix design shall meet the engineer's specifications and conform to national and local standards, regulations or codes having jurisdiction.

Canada CSA A23.1-2-3 and CSA A 438
United States ACI 318 or ACI 332

The NUDURA® form units, made of EPS, will enhance the performance of the concrete as follows:
- enhances the concrete strength
- excellent thermal protection for winter construction
- minimize the early shrinkage which is the cause of cracking in the walls
- concrete is not exposed to the elements

The main characteristics and specifications for a NUDURA® compatible concrete mix should be as follows:
- Portland cement: Type 10 (Normal)
- Designed compressive strength at 28 days: 3000 psi (20 MPa)
- Slump on site: 6" (150mm)
- Water/cement ratio: Maximum 0.60
- Aggregate maximum size:
    - Wall of 4" (100mm) and 6" (150mm) nominal concrete thickness: 3/8" (10mm) to 1/2" (13mm)
    - Wall of 8" (200mm), 10" (250mm) and 12" (300mm) nominal concrete thickness: 3/4" (19mm)
- No air entrainment (usually 3% to 5% present)
- Fresh concrete density: 4080 lb/yd^3 ± (2400 kg/m^3 ±)
- Setting time (dependent on temperatures): 3 – 7 hours
- Concrete design strength should be reached at 28 days

2.17 CONCRETE PLACEMENT

The placement of concrete in a NUDURA® wall shall be in accordance with the plans and specifications and must comply with local standards, regulations or codes having jurisdiction.
Concrete placement shall be in accordance with:

Canada CSA A23.1-2-3 and CSA A 438
United States ACI 318 or ACI 332

Various methods of placement can be used depending on the accessibility to the site and the characteristics of the project. Other variables such as temperature, mix design and reinforcing pattern in the wall may influence the builder's decisions as to the technique selected for the concrete placement.

Concrete can be placed using the following methods:
- Concrete boom pump
- Concrete pump
- Crane and bucket
- Conveyer belt on or off the truck
- Directly off the truck by chute

The concrete boom pump is the preferred method for above grade construction when available. When using a boom pump it is important to have a reducer (diameter 4" (102mm) maximum) followed by a double 90° bend to reduce the velocity of the concrete entering the wall. Some pumps are also equipped with a flap gate at the end of the double 90°. The flap gate is very useful in keeping the site clean, especially when working on slab or floor surfaces.

As per ACI 304 and CAN/CSA A23.1, concrete placement rate should not exceed 4' (1.22m) of lift per hour. When placing concrete the contractor should avoid completing a pour against a buck or in a corner.

A pour should always be terminated at the center of the longest wall when possible. When placing concrete, the contractor should avoid completing a pour against a buck or in a corner.

2.18 CONCRETE CONSOLIDATION

Consolidated concrete will be dense, homogenous and free of cold joints, void and honeycombing. The concrete shall be well bonded to all reinforcing steel, anchors and embedded parts such as bearing plates.

Concrete can be consolidated by means of hand-tamping, rodding or external or internal mechanical vibration. Of these, internal mechanical concrete vibration is the most effective method to use.

Consolidation of the concrete should always start at the base of the wall and continue upward as each concrete lift is placed. The completed lift should be consolidated before the next lift is deposited.

When consolidating subsequent lifts, the consolidating tool must completely penetrate the lift and extend into the upper portion of the previously placed lift, to ensure proper mixing of the concrete at the interface between lifts.

A 3/4" (19mm) to 1" (25mm) concrete vibrator is the maximum size recommended for consolidating concrete in a NUDURA® wall. Be sure that the shaft length of the vibrator is long enough to reach the bottom of the wall height being constructed.

The contractor should familiarize himself with the proper technique and use of the vibrator.