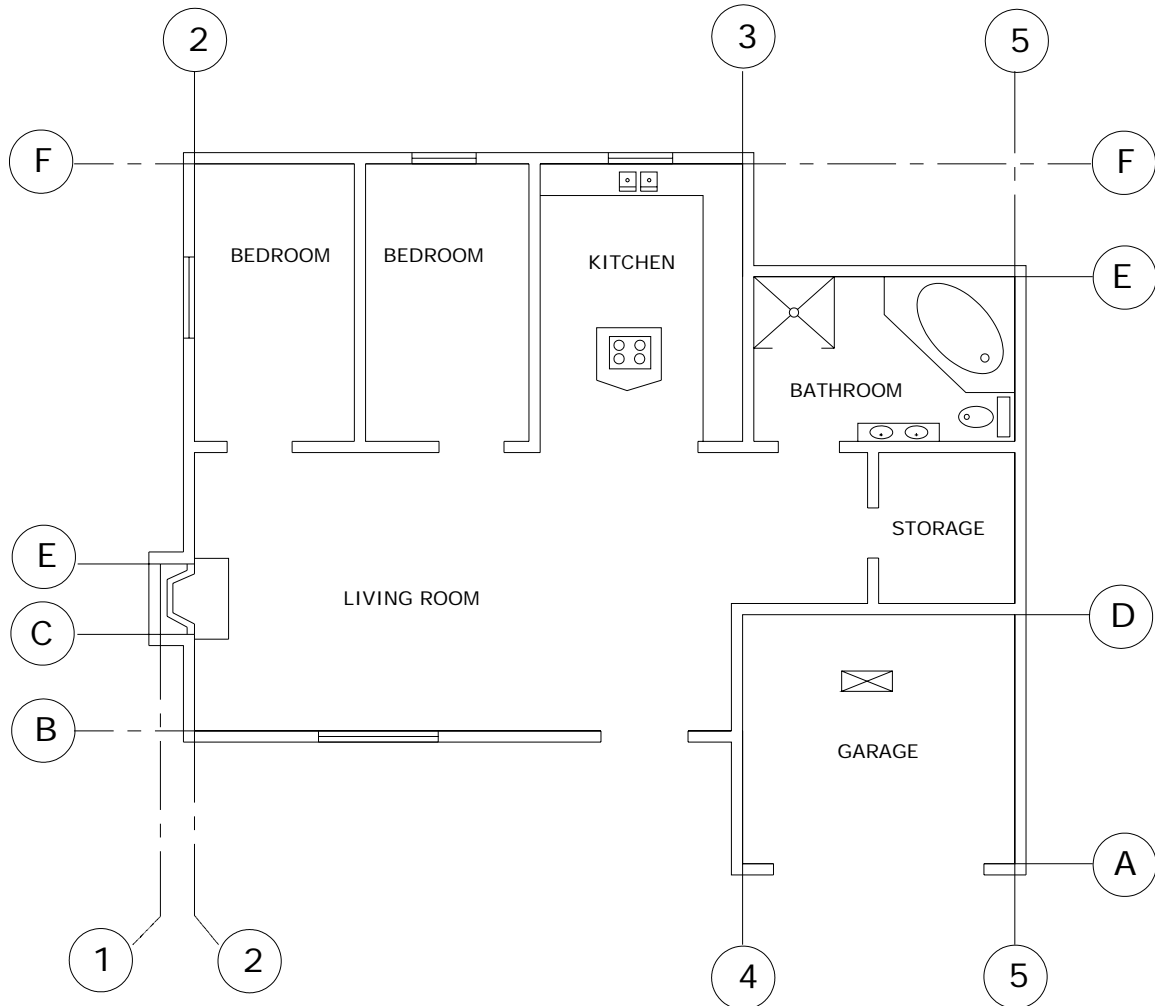


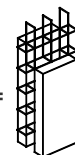
## 1. First Phase: Preliminary tasks



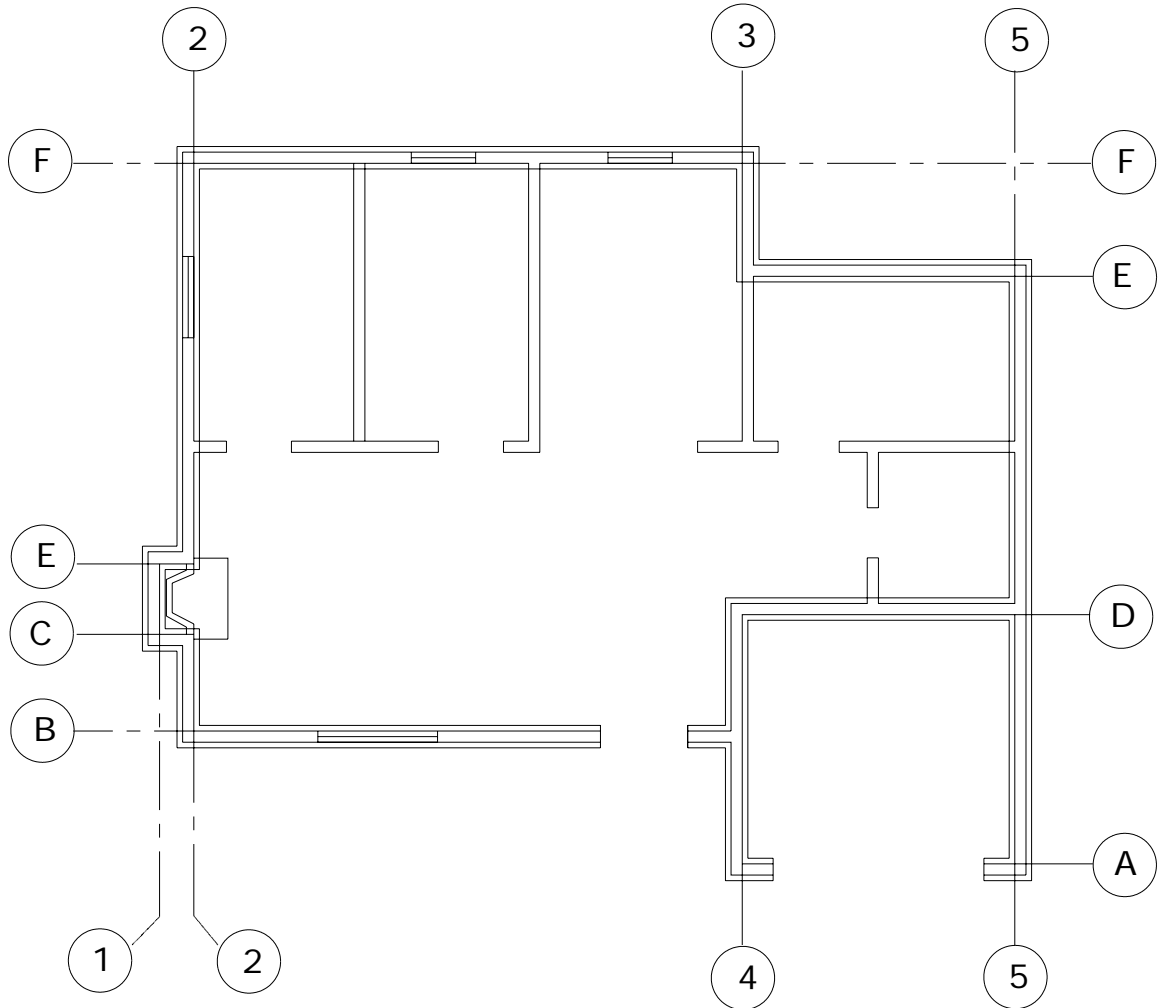
**Figure 1.1** Architectural Floor Plan

If, during the construction phase, you would like to adapt your wall erection system to Armopanel™ stay in place formwork system, you can use this manual to develop shop drawings or supply the manufacturer of Armopanel™ with architectural and structural drawings of your structure so the manufacturer could produce shop drawings.

In the Armopanel™ system the combined thickness of both polystyrene sheets of each panel is 100mm (4"). If your plan is designed for another wall erection system such as wooden frame or concrete block and you would like to adapt your dimensions to suit the Armopanel™ system, there are two options available:



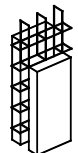
- 1) If you decide to keep the inside dimensions of the building intact, the use of the Armopanel™ formwork will cause the building's dimensions to increase by 200mm (8").



**Figure 1.2** Armopanel™ Floor Plan

- 2) If the increase of the outside dimensions is unfavourable (due to a property line), you may choose to decrease the inside dimensions of the building by 200mm (8"), thus keeping the outside dimensions intact.

The height of the panels should be determined according to the floor height. The layout of the panels is designed with consideration for the locations of window and door openings. The panels could be cut at any place between plastic caps to accommodate door or window openings.



## 1.1. Estimation for the required number of formwork panels

For plain panels with 1200mm (4') thickness:

- Multiply the outer perimeter of the building by the wall height. Subtract the areas of corners and T- panels. The resulting number will be the area of the plain panels.
- Calculate the areas of windows and doors and subtract from the total area of the plain panels.
- Divide the area of the plain panels by the area of one plain panel, 2.97 m<sup>2</sup> (32.0 ft<sup>2</sup>), to obtain the required number of plain panels.
- Add up to 3% for waste.

For corners:

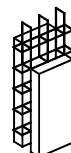
Determine the length of the corners. Multiply the result by the height of the wall to obtain the area of the corner panels. Divide the area of the corner panels by the area of one corner panel to obtain the required number of corner panels.

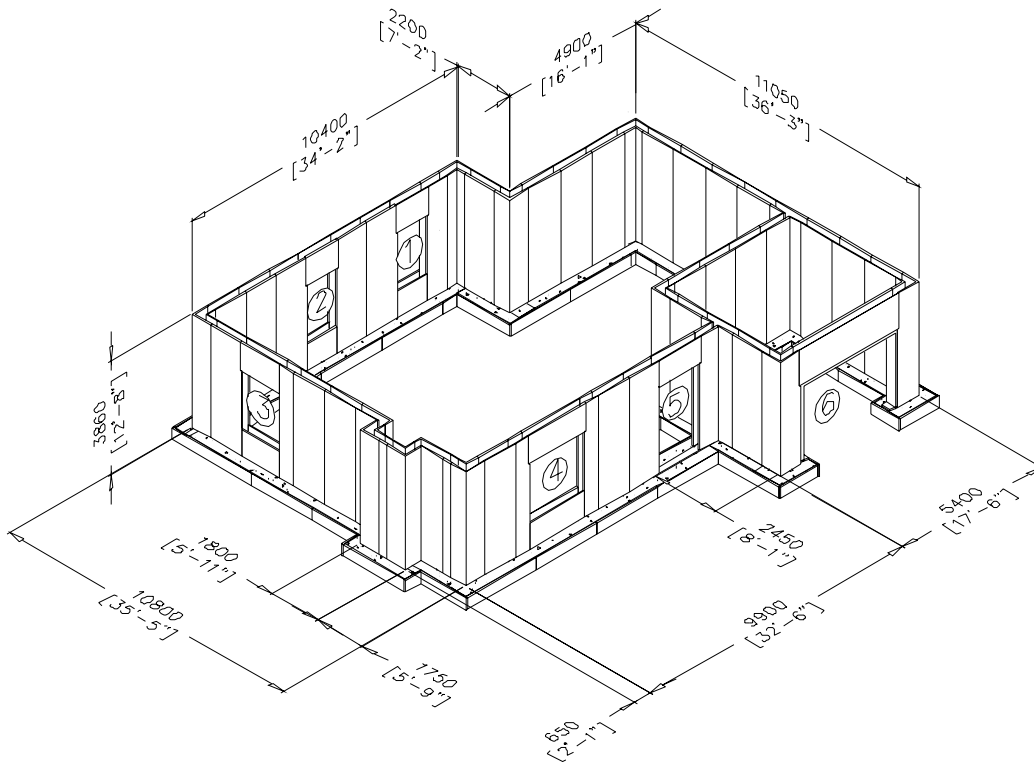
For T-panels:

Determine the length of the T-panels. Multiply the result by the height of the wall to obtain the area of the T- panels. Divide the area of the T-panels by the area of one T-panel to obtain the required number of T-panels.

### Example:

<b>Height of the wall:</b>	3.86m (12'-8")
<b>Thickness of the wall concrete:</b>	0.254m (10")
<b>Area of the plain panel:</b>	1.22 x 2.44 = 2.97m <sup>2</sup> (48" x 96" = 32.0 ft <sup>2</sup> )
<b>Area of the corner panel:</b>	(0.78 + 0.595) x 2.44 = 3.36m <sup>2</sup> (31" + 23") x 96" = 36.0 ft <sup>2</sup> )





**Figure 1.3**

**Area of T-panel:**

$$(1.22 + 0.35) \times 2.44 = 3.83\text{m}^2$$

$$(48'' + 13.6'') \times 96'' = 41.0\text{ft}^2$$

**Outer perimeter:**

**64.95m (213ft)**

$$10.8 + 10.4 + 2.2 + 4.9 + 11.05 + 5.4 + 5.4 + 2.45 + 9.9 = 64.95\text{m}$$

(213ft)

**Area of the walls:**

**250m<sup>2</sup> (2705ft<sup>2</sup>)**

$$64.95 \times 3.86 = 250\text{m}^2 \text{ (213' x 12'-8" = 2705ft}^2\text{)}$$

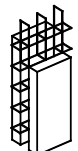
**Number of corners:**

**10**

**Area of the corner panels:**

**53.1m<sup>2</sup> (570ft<sup>2</sup>)**

$$10 \times (0.78 + 0.595) \times 3.86 = 53.1\text{m}^2 \text{ (10 x 31" + 23" x 12'-8" = 570ft}^2\text{)}$$



**Number of T-junction of the walls:** **2**

**Area of T-panels:** **12.12m<sup>2</sup> (130ft<sup>2</sup>)**

$$2 \times (1.22 + 0.35) \times 3.86 = 12.12\text{m}^2 [2 \times (48'' + 13.6'') \times 12'-8'' = 130\text{ft}^2]$$

**Area of the plain panels:** **184.78m<sup>2</sup> (2005ft<sup>2</sup>)**

$$250 - 53.1 - 12.12 = 184.78 \text{ m}^2 [2705 - 57 - 130 = 2005 \text{ ft}^2]$$

**Door and Window Openings:** Type 1 = 2.6m<sup>2</sup>, Type 2 = 2.6m<sup>2</sup>,  
Type 3 = 3.6m<sup>2</sup>, Type 4 = 4.8m<sup>2</sup>,  
Type 5 = 5.215m<sup>2</sup>, Type 6 = 9.77m<sup>2</sup>

**Total area of the Door and Window openings:** **28.7m<sup>2</sup> (307ft<sup>2</sup>)**

$$2.6 + 2.6 + 3.6 + 4.8 + 5.215 + 9.77 = 28,7\text{m}^2 (307\text{ft}^2)$$

**Subtract the opening area from area of plain panels:** **184.78 – 28.7 = 156.08m<sup>2</sup>**

$$(2005 - 307 = 1698 \text{ ft}^2)$$

**The required number of the plain component panels:** **156.08 : 2.97 = 53 panels**

$$(1698 : 32 = 53)$$

**Add 3% for waste:** **53 x 1.03 = 55 (plain panels)**

**The total number of the required panels:**

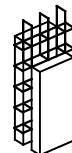
**Plain:** **55**

**Corner:** **53.1m<sup>2</sup> : 3.36m<sup>2</sup> = 16**

**T-shaped:** **12.12m<sup>2</sup> : 3.83m<sup>2</sup> = 4**

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**TOTAL:** **75**



1.2. Estimate of the required number of connecting details and volume of the concrete.

**U- Guide:**

The quantity of elements is equal to the perimeter of the walls divided by the length of one U-Guide.

**Connecting details:**

- Multiply the total number of plain panels by 8
- Multiply the total number of T-panels by 12
- Multiply the total number of corner panels by 8
- Add the three resulting numbers together

**Concrete:**

The quantity of concrete is calculated in the following manner:

- Multiply the perimeter of the wall by the floor height and thickness of the wall.
- If the building has walls of various height and/or thickness, the amount of concrete is determined separately for each individual wall. Combine these individual amounts of concrete.
- Determine the volume of each door and window opening, brick-ledge and protruding element. Deduct these amounts from the total volume of the walls.

**Example:**

**Fixing U-Guide:**

	53 units
Total number of elements=	$41 + 10 + 2 = 53$
Perimeter =	64.95m (213 ft)
Length of the corner panels =	$(0.78 + 0.595) \times 10 = 13.75\text{m (45 ft)}$
Length of T-panels=	$1.2 \times 2 = 2.4\text{m (4 ft)}$
Length of the plain panels=	$64.95 - 13.75 - 2.4 = 48.8\text{m (160 ft)}$
Number of the plain panels=	$48.8 : 1.2 = 40.67 = 41$
Number of the corner panels=	10
Number of T-panels=	2

**Connecting details:**

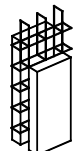
For Plain panels:	$55 \times 8 = 440$
For Corner panels:	$16 \times 8 = 128$
For T-panels:	$4 \times 12 = 48$
Total number of the connecting details:	$400 + 128 + 48 = 616$ units

**Concrete:**

Perimeter:	64.95m (213 ft)
Wall height:	3.86m (152")
Thickness of the wall concrete:	0.254m (10")
Concrete amount without deduction of door and window openings:	$64.95 \times 3.86 \times 0.254 = 63.68\text{m}^3$ (83.4 yd <sup>3</sup> )

**Amount of door and window openings:**

$$(2.6 + 2.6 + 3.6 + 4.8 + 5.215 + 9.77) \times 0.254 = 7.26 \text{ m}^3 \text{ (9.5 yd}^3\text{)}$$



Deduct the door and window openings volume from the total wall amount to get the total concrete amount for the entire building:  $63.68 - 7.26 = 56.42 \text{ m}^3$  (92.9 yd<sup>3</sup>)

### 1.3 Estimate of the Quantity of Reinforcement

The calculation below is presented only for demonstration purposes. The quantities of the concrete, sizes and placements of reinforcement pertain only to this specific example. In a specific project, these specifications are calculated by Engineers or are selected from the schedules attached to the manual.

Armopanel™ is a system for erection of concrete walls, which allows the spacing of horizontal or vertical reinforcement @ 200mm (8") or 400mm (16").

Assuming that we need to install vertical reinforcement 10M (#3), at the interior and exterior faces @ 200mm (8"):

- Four 10M rebars are installed vertically at both sides of each door and window opening;
- Two additional 10M rebars are installed horizontally atop every door and window opening;
- Two short diagonal rebars are installed at every top corner of the opening.

Rebars are to be spliced. The minimum length of the splice is to be at least 30 times the diameter of the rebar. The reinforcement should be ordered with length, which includes both the height of the wall and the necessary length of the splice according to structural drawings.

#### Vertical Rebars

The total number of vertical rebars is determined by dividing the total length of the reinforced walls by the space between rebars.

The length of the reinforced walls is determined by deducting the lengths of door and window openings from the total length of the walls.

**Horizontal rebars** are installed by two options:

- 1) One or two rebars @ 200 mm (8") depending on structural specifications.
- 2) One or two rebars @ 400 mm (16") depending on structural specifications.

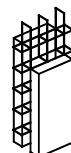
Horizontal rebars should have length from 1600 to 2800mm (9' – 2.34")

- Calculate the quantity of horizontal reinforcement which includes the necessary splicing,
- Add vertical rebars including two additional rebars installed along the each side of the door and window opening.

#### Example:

#### Vertical reinforcement:

Building perimeter:	64.95m (213 ft)
Total length of openings: $4.88 + 1.75 + 2.4 + 1.8 + 1.3 + 1.3 =$	13.43m (44 ft)
Total length of the building's reinforced walls: $64.95 - 13.43 =$	51.52m (169 ft)
Space between rebars:	200mm (8")



Length of one rebar: 3.86m (152")

Required number of 10M rebars installed at exterior panels face with  
 $L=3.86\text{m (152")}$   
 $51.52 : 0.2 = 258$  rebars

Each door and window opening requires two diagonal and vertical rebars (1.2m [48"]) on each side.

Eight rebars are required per each door and window opening.

Six openings require the following:  
 $L=1.2\text{m(48")}$ ,  $4 \times 6 = 24$  rebars  
 $L=3.86\text{m(152")}$ ,  $4 \times 6 = 24$  rebars

Add 3% waste:  
 $L=3.86\text{m (152" )}$   $258+258+24 = 540 \times 1.03 = 557$  rebars  
 $L=1.20$  (48" )  $24 \times 1.03 = 25$  rebars

### **Horizontal reinforcement:**

For panels with concrete thickness of 250mm (10"), the horizontal reinforcement is as follows: two D8 rebars (0.319") @ 200mm (8") or two 10M rebars (#3) @ 400mm (16").

Perimeter = 64.95m (213ft) minus the length of openings:

$$(4.88 + 1.75 + 2.4 + 1.8 + 1.3 + 1.3 = 13.43) = 64.95 - 13.43 = 51.52\text{m (169ft)}$$

The number of rows of horizontal reinforcement in the panels = 19

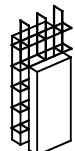
Total number of D8 rebars (0.319") with overlapping  
 $(2.8 - 0.32 = 2.48): 51.52 : 2.48 = 20.77 \times 19 = 395$  rebars with  $L=2.8\text{m (9'-2")}$ .

Horizontal reinforcement of the openings requires additional 8 rebars (3.6m) per each opening:

		$8 \times 6 = 48$ rebars
Add 3% waste:	$L=2.8\text{m}$	$395 \times 1.03 = 407$ rebars
	$L=3.60\text{m}$	$48 \times 1.03 = 50$ rebars

### **Notes:**

- If another floor is to be built with Armopanel™ on top, the rebar length should be extended to 350-600mm (12 – 24") above the first floor level (in order to provide splice between rebars).
- Horizontal reinforcement is installed to decrease the effects of shrinkage of the concrete, creep and changes of temperature. The minimal area of horizontal reinforcement is to be in compliance with the local building code.
- Vertical and horizontal reinforcement are to be designed to sustain all forces of live and dead loads as per the code.



## 1.4. Labor

When building with Armopanel™, the best results are achieved if the construction crew consists of:

- One experienced carpenter,
- One experienced concrete worker,
- One or two labourers.

### Labor cost:

Thorough study of the Armopanel™ system allowed us to develop labour rates. Such rates assume that the foundations and concrete slabs are prepared for the installation of the first row of panels. In addition, these rates assume that the standard height of a panel is 2.4m (8'). These rates include Armopanel™ formwork placement, installation of reinforcement and alignment system as well as the cleaning of the site.

### Basement Walls

The rates vary from 0.035 to 0.055 man-hrs/ft<sup>2</sup> of wall area (from 0.377 to 0.592 man-hrs/m<sup>2</sup>). For instance, if an experienced labourer is paid \$15.00/hour, the labour cost will be 0.035 man-hrs/ft<sup>2</sup> x 15.00/hour = \$0.525/ ft<sup>2</sup> (0.377 x \$15.00/hr = 5,655/m<sup>2</sup>) out of wall area. As soon as each form unit has 32ft<sup>2</sup> (2.97m<sup>2</sup>), the labour cost per each form will be \$16.8/form unit.

If the design of the building is more complex, and for example:

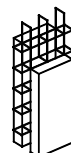
- The floor height is larger than the standard
- There are many differences in height along the wall length
- There are many corners and T-shaped wall crossings,

the labour costs will be higher and based on rate as 0.55 man-hrs/ft<sup>2</sup> or \$0.825/ft<sup>2</sup>, or \$0.825 x 32 ft<sup>2</sup> of the form unit = \$ 26.4/form unit.

### Above- Grade Walls

Labour rate vary from 0.055 to 0.07 man-hrs/ft<sup>2</sup> of the wall area. The cost is higher due to the fact that there are usually more window and door openings. Thus, the data based on \$15.00/hr at rate 0.055 man-hrs/ft<sup>2</sup> will be equal to \$0.825ft<sup>2</sup> of the wall area or \$ 25.58/form unit. At the higher rate as 0.07man-hrs/ft<sup>2</sup> at rate \$ 15.00 per hour, it will be \$ 1.05/ft<sup>2</sup> of the wall or \$32.55/form unit.

This data of labour costs is only an example. Actual costs may differ due to design complexity and the level of experience of the crew.



## 1.5. Instruments

The main instruments used during the work performance:

- 1) Reciprocating saw- used for formwork cutting
- 2) Hand saw- used for straight and longer cuts
- 3) Cordless screwdriver- used to attach details to the panels by means of screws
- 4) Key-hole saw- used for small cuts as well as for door and window openings
- 5) Electric screwdriver with a special Armopanel™ nozzle- used for the attachment and removal of plastic caps
- 6) Rebar tie wire- used to secure rebars in the designed position
- 7) Hot knife with attachments- used for precise cutting of polystyrene
- 8) Wire tying tool- facilitates the wiring of the rebars
- 9) Hammer- used for various types of work
- 10) Foam adhesive- used for gluing and the filling of gaps
- 11) Router- facilitates the fast shaving of polystyrene; requires 1/2" bit for cutting grooves and openings for cables and boxes

