



FORSA SYSTEM
BUILDING THE FUTURE
STEP BY STEP

FORMWORK SYSTEM



Types:

Wall forms

(FM)

Standard form 60cm wide with heights between 210 and 240 cm.



Slab forms

(FL)

Standard 90 x 120 formworks. But according to required design they can handle widths and lengths from 10 to 90, with different combinations.



Wall slab union

(WSL)

Profile used as a connector between the FL and FM. Razor (7 mm.) WSL 5,10, 20, 25.



Other

- Complement form
- Exterior angle
- Internal wall corner
- Butts
- Wall covers









FORMWORK SYSTEM



Accesories






Fastening accesories:

Used to attach panels together:

- Arrow pin 
- Threaded bolts 
- Pins (flat, short. Medium, large) 
- Staple pin 
- Wedges 
- Ties 

Aligning accesories:

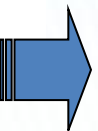
Used to align walls:

- Horizontal aligner 
- Wall tensor 
- Fixed and adjustable tensors 
- Internal aligner for WSU 
- Wall complements aligner 

Tool kit:

Specially designed tools for assembly and disassembly.

- Formwork puller 
- Tie puller 
- Leveling crowbar 



FIRST HAND MATERIALS



Consumables

Tie covering:

Its thickness should be 3 mm, amount depends on ties number to be installed in each assembly.

For first assembly, it is recommended to dip ties into release agent.



Plastic separators for walls and slabs:

To assure concrete covering wire mesh.

One per m2 on walls and 2 per m2 on slabs.



Steel wool:

To clean edges and panels contact surface.

200 gr. Unit per 10 pours.



PRELIMINARY TASKS



Remove topsoil, fill with new compacted and leveled material.



Accurately locate reinforcing steel, hydraulic, sanitary and electrical networks.

PRELIMINARY TASKS



- The accuracy for the location and project reference axes, is achieved using "axis banks", which are small rigid wooden porches, at foundation perimeter, in which theoretical axes of the building are materialized. They are very important!



PRELIMINARY TASKS

- Surveyors shall identify each point of the building and materialize them in the axis bank, location and layout must be tied to milestones or fixed references aside work area.



PRELIMINARY TASKS



- ❏ Install wire mesh or reinforcement starts on foundation slab.



PRELIMINARY TASKS



- ❏ Before pouring slab concrete, a final check is required to make sure everything is properly set.
- ❏ To obtain a better surface finishing, use a vibrator while pouring and an aluminum bull float if possible.



PRELIMINARY TASKS




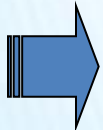
To save time before the arrival of the equipment there must be at least the following construction progress:

❑ Foundation slabs

- 🔧 Must be corner squared, leveled and with precise dimensions.
- 🔧 Well marked trace of walls.
- 🔧 Reinforcing steel of walls properly placed, with exact doors and windows dimensions.
- 🔧 Ties and pins of Forsa formworks starts at 15 cm. off the floor, so when installing reinforcement steel you must verify that the first horizontal line of wire mesh does not match this point so as not to interfere with ties.
- 🔧 All of the electrical, hydraulic and sanitary pipes tightly placed on wire mesh.
- 🔧 If foundation slab have not considered the formworks width, you must use wooden stools 4 X 4 inches to support them.

FOUNDATION SLABS

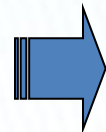
-  Must be corner squared, leveled and with precise dimensions.



PRELIMINARY TASKS

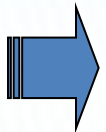


- Well marked trace of walls including door openings.




PRELIMINARY TASKS

- Imperative (more on facades) the tracing of an additional axis located at a known distance (+5.4) to verify the correct position of the panel, this is done because the formwork hides the walls traced axes.



PRELIMINARY TASKS



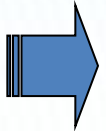
 Walls reinforcing steel properly placed, with exact doors and windows dimensions. Important to attach required spacers to ensure optimal steel coating.



PRELIMINARY TASKS



- ▣ All of the electrical, hydraulic and sanitary pipes placed on wire mesh.



PRELIMINARY TASKS



- ❏ If for foundation slabs the formworks width have not been considered, you must use wooden stools 4 X 4 inches to support them. ALWAYS ENSURING TOTAL SUPPORT OF WALLS OVER THE SLAB.



PRELIMINARY TASKS



- Preparation of pipes:
It is important to have the largest number of cuts and welded electrical, hydraulic and sanitary accessories on pipes. Ties and their covers are part of these previous enlistments ranging in pursuit of productivity.



PRELIMINARY CHECKLIST



Once preliminary activities are finished and before starting formwork assembly, you shall verify:

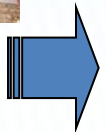
- Right position of pipes and boxes (in plan and elevation) as installation projects.
- Appropriate fixation to wired mesh.



PRELIMINARY CHECKLIST



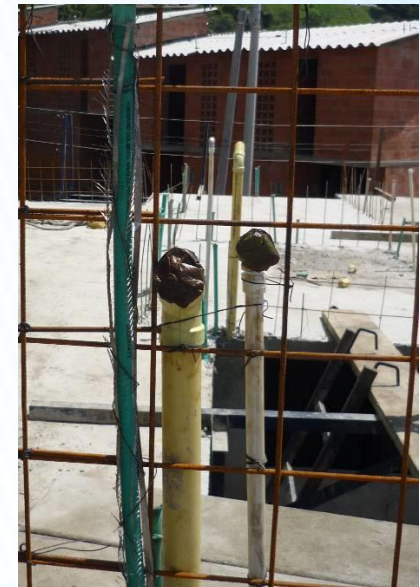
- Clearance (in length) between pipes to allow concrete to completely surround pipes.
- Guarantee electrical contact between boxes and mold surface (there should be no separation in thickness).



PRELIMINARY CHECKLIST



- Sufficiency of traces, defining openings.
- Hydraulic test to all pressurized water circuit (minimum 100 PSI for 3 hrs.).
- Ideal PVC plugs on sewage pipes, but at least circuit must be sealed.
- Reinforcement separators (maximum spaced 1 m), minimum two rows: in half and top.
- Overlaps of the reinforcement, th discretion of the estimator (2 cells



PRELIMINARY CHECKLIST



Safety

SAFETY GOGGLES

For eye protection against concrete and even metal debris at high speed while hammering pins and wedges



BOOTS, HELMET, HARNESS AND VEST

Steel toe boots. A standard panel weights 27 kg. and it can fracture finger toes.

Harness for safe work on heights.
Vest must be reflective and have name on it.

EAR PLUGS

Repetitive hammering when installing formwork can produce up to 120 decibels, this can produce deafness over time, so it is essential for workers protection.



PRELIMINARY CHECKLIST



Required tools per worker

HAMMER

Used to set the pins and wedges. Never hit the contact face or side panels directly with the hammer. A piece of wood should be used instead, to distribute the impact over the panels.



SCRAPER TOOL

For daily cleaning of panel sides and contact face.

If panel contact face is dirty, stucco thickness is increased and panels become heavier, therefore more difficult to handle.

If sides are dirty, dimensions will be increased and assembly over axes will be hard to get accurately.



MEASURING TAPE

Ensures accurate measurements, it should be 5 meters long.



BUCKETS

2 buckets per worker, one for pins, wedges and staples, another one for ties. This reduces loss of accessories and facilitates inventories. Small buckets are preferred (weight and lifespan).



GLOVES

Essential for security

For better grip of panels.

Better handling when panels are hot or very cold.



STEP BY STEP - PINING



- The process begins with the pinnate process, which is nailing pins to restrict movement at the wall base to ensure panels position at their respective traced line.
- There are many kinds and you can choose the best available option depending on price, availability, versatility and performance.

STEP BY STEP - PINING



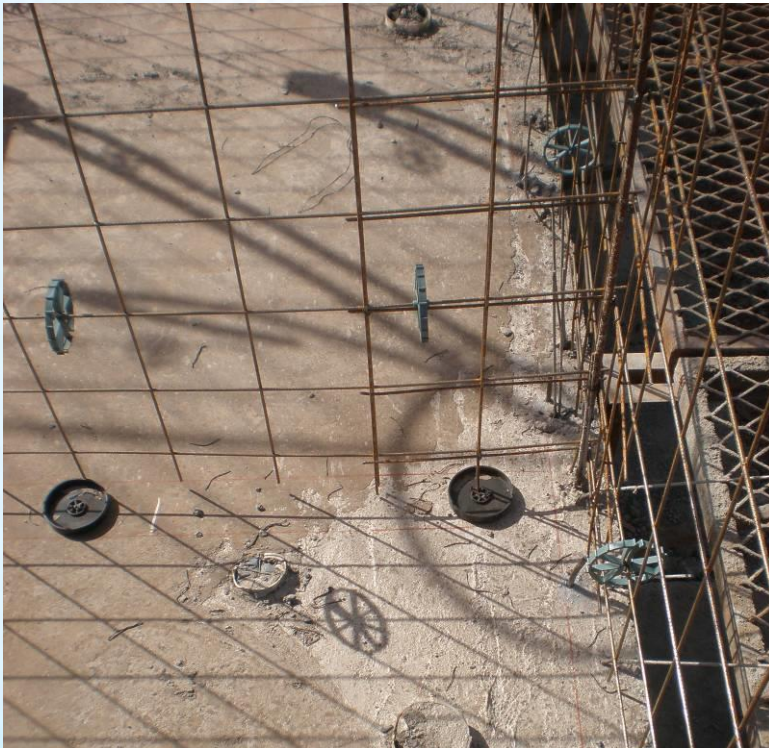
- There are steel nails, rod pieces (no more than ½ "): several steps, destructive slab, good results
- Plastic or metal U caps: less steps, expensive, less harmful for slabs.



STEP BY STEP - PINING



- Plastic spacers: ideal for internal walls, because they deform easily. Few steps.
- Wood restrictions: more steps, material waste, poor performance. Made after panels assembly.



STEP BY STEP - PINING



□ Forsa formwork system is so convenient and its modular assembly can be achieved in two ways:

✚ Assemble the inner wall formwork and then mount the outer wall formwork.

✚ Assemble simultaneously interior wall and exterior wall formwork. This assembly sequence is recommended by Forsa for being more agile, quick and safe.

STEP BY STEP - PINING



- ❏ Forsa ties start at 15 cm. from the floor, so to install steel you must verify that the first line of horizontal steel mesh does not match this height so it does not interfere with the tie to be later installed.



STEP BY STEP - WALLS



- Begin installation at the corners, placing forms upon the wall traces. Formworks must be cleaned after disassembly and a release agent must be applied on sides and contact face.



STEP BY STEP - WALLS

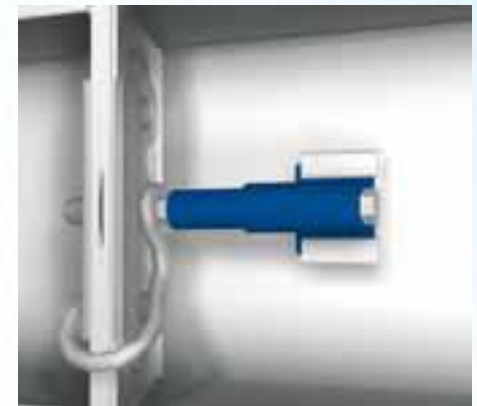
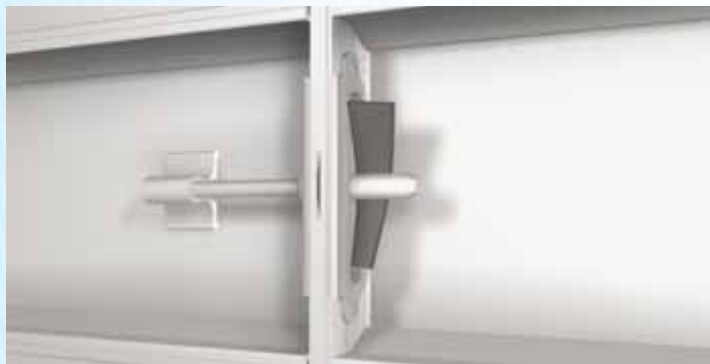


- Fix wall formworks on each side of a wall corner so that it can remain standing.
- To attach formworks slide and introduce arrow pins through drilled bores on the formworks sides.




In height, it is recommended to start by the internal faces of walls facades

STEP BY STEP - WALLS



STEP BY STEP - WALLS




 Finally fix the formworks inserting the wedge through the pin bore. Ties must be placed before adjusting pins and wedges.



STEP BY STEP - WALLS




-  The tie acts as a separator ensuring the thickness of the walls, and it also supports pressure when pouring concrete.



STEP BY STEP - WALLS



 Repeat the above steps for every wall. When all the walls are closed including wall covers you know how much time is taking your daily walls cycle.



STEP BY STEP - ALIGNMENT



- ❏ To improve walls alignment, a horizontal aligner with its respective steel angle must be installed. Its purpose is not propping, only walls alignment.
- ❏ Insert every horizontal aligner between panels cada portaalineador en las uniones de la cimbra forming two rows along the formwork: one below to align the base and one up to align the top.



STEP BY STEP - ALIGNMENT



- ❏ A steel angle aligner must be installed over horizontal aligners. Use a commercial 2 ½" x 2 ½" x ¼" angle .
- ❏ When walls are 100% aligned, proceed to plumb them.
- ❏ Remember that if there are empty spaces between the walls formworks and the slab, you must fill them with any material.



STEP BY STEP - ALIGNMENT



- Walls can be restricted on the base (in addition to pins), using wood in areas in areas that require further propping and precision (like doors and windows openings, closets walls, etc.)



STEP BY STEP - VERTICALITY




- Verticality is achieved using wall tensors to "force" the panels to be completely vertical. After a final check (with plumb or similar), proceed to the installation of tensors in doors and windows.



STEP BY STEP - WSU



 A “wall slab union” is a transition profile available on 2 shapes: square angle and ledge profile. There is also a butt formwork, which is used on slanted slabs.



STEP BY STEP - WSU




- ❏ Zero or razor WSU is an aluminum 7 mm profile which lies on wall panels and is attached to slab panels.



STEP BY STEP – WSU - BUTTS



 Install the wall slab union and attach it to wall panels with staple pins. If the WSU is taller than 40 cm, a third line of aligners should be used. Be sure to check verticality as well as alignment.



STEP BY STEP - SLABS




- According to Forsa drawings install slab forms and attach it to the WSU with staple pins. When attaching slab panels between them, use pins and wedges where possible.



STEP BY STEP - SLABS



 Keep attaching slab forms between them using short pins and wedges. It is imperative to install props while assembling slab panels to keep flatness and to ease leveling.



STEP BY STEP - SLABS



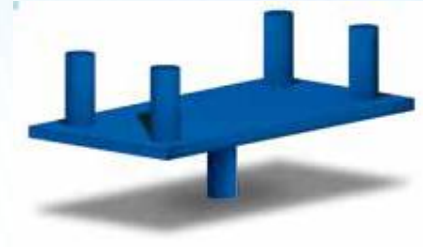
- ✚ *Underpinning slab system*
- Proceed as mentioned before, installing underpinning slabs as shown on drawings, attach them to adjacent panels with staple pins and use a jack over the slab pin to achieve required propping.



STEP BY STEP - SLABS



- Use jack supports with their respective jacks to keep the slab leveled. Its location must be made according to Forsa drawings, guaranteeing support to slab at the juncture of slab formworks.



STEP BY STEP - SLABS



After completing slabs assembly, proceed with precision leveling, this should be made with precision equipment over the slab, reporting mm or cm required to get the theoretical level; it is also possible to level below the slab with a laser level or with a proper mark made with thread tied to props at a known height, for which readings and adjustments will be made to jacks to achieve the theoretical level.

STEP BY STEP - SLABS



After leveling the slab, proceed to install the lower wire mesh, hydraulic, electrical and sanitary pipes with their respective accessories. Afterwards install upper wire mesh, keeping all the pipes beneath to avoid cracking. Check the position of wire separators, moorings and steel overlaps.



FINAL CHECK



Once the set is closed with all its accessories (pins, wedges, ties, **aligners**, props, etc.), proceed with a detailed inspection of:

- Verticality, dimensions and square angles.
- Walls alignment
- Slabs flatness
- Proper positioning of accessories (pins, wedges, ties)
- Proper positioning of underpinning slabs and jack supports.
- Proper positioning of prop jacks, tensors and openings braces.
- General cleaning.

It's also advisable to apply release agent or Diesel over the exterior face of the set (with a spray pump or roller nap) to avoid concrete crusting over the aluminum.



FINAL CHECK



Before pouring concrete, make a thorough washing of all concrete surfaces that will receive new concrete. This to hydrate and remove debris on floors and slabs that could compromise the adhesion and sealing of the walls.

The concrete should meet the required specifications for the construction system, that is, small diameter of coarse aggregate ($3/8'' - 1/2''$ for walls and $3/4''$ for slabs), consistency (8" slump for walls and 6" for slabs) and proper dosage according to design.



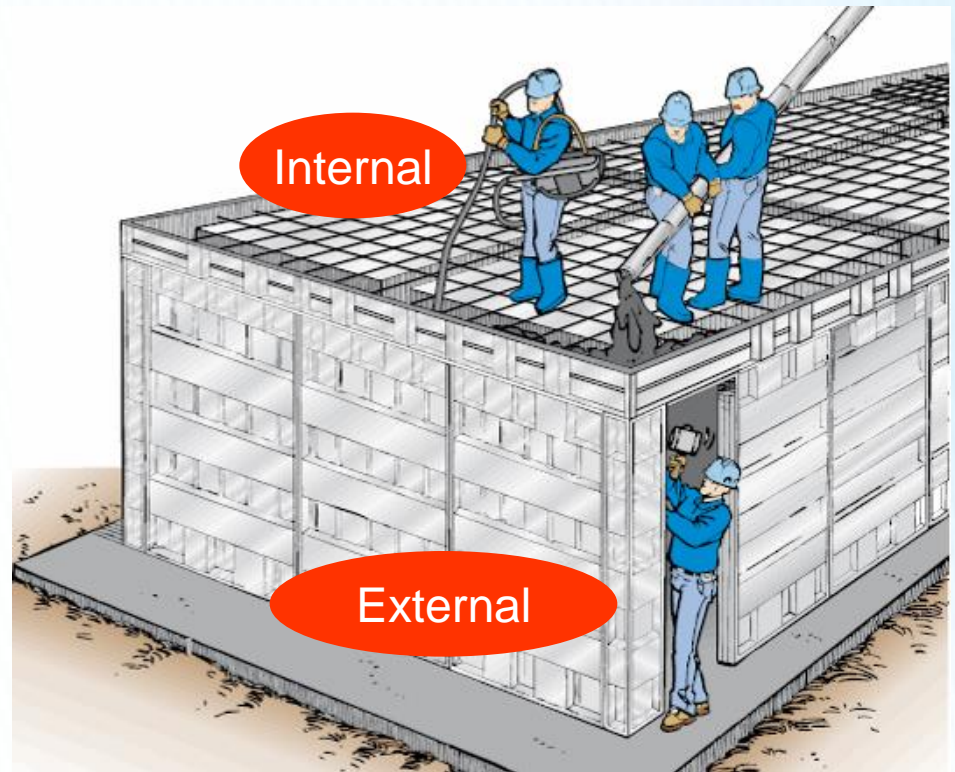
POURING CONCRETE



Begin pouring concrete at one end of the set and as walls are being filled, introduce an internal vibrator with a maximum head size of 35mm, that must go up and down slowly and steadily to the bottom of the walls.

External vibration must be made at the same time, hitting the forms with a rubber mallet on panels reinforcements.

These recommendations help to eliminate air chambers at the interior of the walls and to ensure the correct filling of elements.



POURING CONCRETE



During **pouring process** spread concrete evenly on the slab avoiding to overload small areas, this is to keep the slab flatness and to not submit the formwork to unnecessary overloads.

Concrete pumping hose must **NOT** be higher than 90 cm to avoid damage to the slab formwork by impact.



POURING CONCRETE



In addition to leveling slabs with precision equipment, it's possible to check the slab thickness using a measuring rod (a steel bar with marks at desired measures will do the job).

After screeding the concrete, it is floated to further compact the concrete, even out any depressions or high areas, and create a smooth finish on the surface.

During this process the surveyor must be part of the workers team to ensure precision at leveling.



POURING CONCRETE



While pouring concrete it is recommended to wash the set with a pressure washer to avoid concrete crusting on panels. When water supply is not possible an alternative would be to spray diesel before pouring concrete and to clean using brooms or brushes during the process.



DISASSEMBLY



Next day after pouring concrete, the work cycle starts with the set disassembly.

Walls formwork:

1- Every worker must remove aligners, tensors, braces, pins and wedges from its assigned space.

Use a hammer to release pins and wedges being careful not to hit the aluminum panels.

2- Once wedges are removed, arrow pins must be moved to its left.



DISASSEMBLY



3- Starting from the middle of the walls, choose the smaller formwork and take it off using the **“formwork puller”**, which is an essential tool for this operation. Move the formwork to the next housing unit.

Make sure that formworks are pulled back uniformly to guarantee quality in finished concrete.



DISASSEMBLY



Before the next assembly, proceed to clean every side of the formwork with a spatula and wire wool or wire brush. After removing any concrete crusting, apply a release agent. This must always be made.

Start the second assembly as made the day before, installing every formwork in the same place it was placed before.

The process becomes repetitive, while the set is being disassembled on one unit, it is being assembled on another one.



DISASSEMBLY



After finishing the walls disassembly, using a hammer remove staple pins, pins and wedges from slab formworks, then remove the formworks, clean them as mentioned before and move them to the next housing unit. Underpinning slabs with corresponding jacks must remain in place for at least 3 days.

The process is cyclical and must be repeated until the project gets finished.



DISASSEMBLY



Meanwhile the ties are being removed with the **“tie puller”**, an specific tool designed for this purpose and provided with the Forsa set; it works like a drop-hammer.



Ideally every worker must be assigned to one task or area, thereby specialization is accomplished and efficiency is improved.

Afterwards, cover ties with polypropylene (tie covers) to a new use.

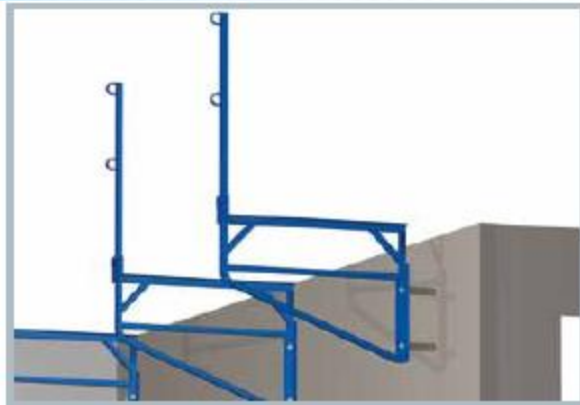


Assembly of upper floors



For the upper floors formwork assembly, exterior walkways should be installed in the entire housing's perimeter, these besides holding up the angles that support the panels of the facade's walls, stairs and elevators vacuum space, also provide the function of generating the exterior platform for the workers' safe movement..

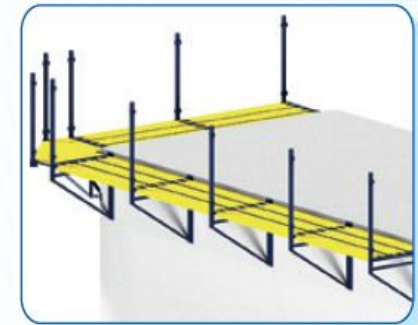
Assembly: Fix 2 ties to every walkway and attach them to the walls inserting the ties in the concrete wall's grooves of the lower floor and secure them on the inside of the wall, with angle wedges, pins and wedges.



Assembly of upper floors



Once all of the walkways around the house have been installed according to the modular blueprints, proceed to install the platforms and lifelines. If wood is used as platforms, it is recommended to support them at maximum 1.80m. in length and wood must be 2" thick, making sure that overlapping is made on a walkway.



Assembly of upper floors

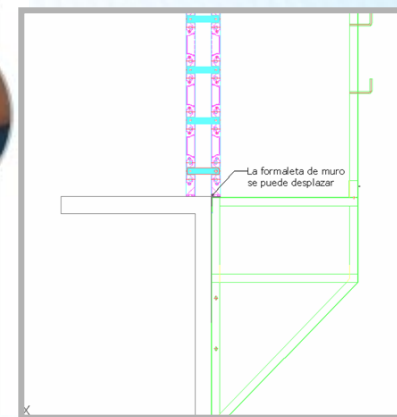


To guarantee optimal support to the facade formworks and achieve a good splice between floors, use the **grooved angles**. These must be inserted into the walkway groove and be adjusted and aligned against the wall.



Once the grooved angles are installed around the perimeter, formworks are moved to the upper floor.

The assembly of facade formworks over the grooved angles must start on one end of the building. When attaching forms use staple pins, for a correct positioning against the lower wall and to achieve a good splice from one floor to the next one.



Assembly of upper floors



Repeat the process again, proceed to locate formworks on the second floor and follow the same procedures made on first floor.



Construction processes with the FORSA system is simple, flexible and organized, achieving high productivity in a short time.



Assembly of upper floors



Thus, after each concrete pour, the slab is screeded and floated, walls traces are made over slab according to blueprints, pining, steel reinforcement and wire mesh is installed, electrical, hydraulic and sanitary pipes are attached, mesh separators are installed on reinforcement, every formwork is sprayed with release agent, then walls forms are assembled and aligned, slab forms gets into place, propping system including jacks is placed, then slab steel reinforcement is installed, electrical and sanitary piping from upper floor according to design, afterwards diesel or release agent is sprayed over the exterior of the set, concrete is poured, vibrated internally and externally while the set is being washed with a hidrojet, concrete on slab is leveled and the process becomes repetitive

Next day formworks are disassembled, moved to the next housing unit, get cleaned, release agent is applied and the assembly process begins again.

Simple, fast, efficient, clean, with lower loss and higher performance. This is the Forsa system and these are the results.



Forsa, building the future