Bianchi Casseforme s.r.l., 43045 Fornovo di Taro (PR), Italy

New Trends in PPVC technology

Prefabricated Prefinished Volumetric Construction (PPVC) is a construction method whereby free-standing 3-dimensional modules are completed with internal finishes, fixtures and fittings in an off-site fabrication facility, before it is delivered and installed on-site.

The use of PPVC allows: Improved Productivity, up to 40% in terms of manpower and time savings, depending on the complexity of the projects; A "Better Construction Environment"–as the bulk of the installation activities and manpower are off-site, it minimises dust and noise pollution and improves site safety; Improved Quality Control-Off-site fabrication in a controlled factory environment can produce higher quality end products.

When using PPVC the following factors need to be considered:

- Early contractor involvement– Developers/project managers should obtain inputs from the PPVC supplier or manufacturer as well as the Main Contractor at the design stage. This helps in developing effective technical solutions for the project. For example, the choice of the right method will dictate the size and number of modules in the design as weight is a major consideration for the lifting of the modules.

- Site/project management – The condition of the roads surrounding the project must be able to accommodate the weight and size of the PPVC module delivery. Access to and within the site must be able to accommodate loaded trailers. It may not be practical to store many large PPVC modules on-site, and a Just in Time (JIT) installation would prevent unnecessary double handling. The crane deployed on-site must be able to handle the weight of the PPVC modules and its location should be properly planned so that it can reach all blocks for the installation of modules.

- Maintenance, replacement, and renovation– It is good practice for developers/builders to provide a homeowner user manual of the PPVC upon completion of the project. For any renovation works, it is recommended for homeowners to engage a renovation contractor, who would use the appropriate tools and follow the instructions provided in the homeowner user manual. There are various types of PPVC construction and one way of differentiating these is to look at the production methods which provide the 3-D block erected on site.

The production methods can be classified as follows:

- "Component Systems", where a series of flat panels are manufactured, then welded together to create the desired final module shape.

    - Advantages:
        - Fast installation

Multi-storey residential building, made of modules in PPVC technology

- Can be 85 to 90 % completed off site
- Extremely fast production. Flat panels can be manufactured quickly and efficiently.
- Extreme design flexibility
- Excellent insulation characteristics
- Reduced material consumption
- Easy to finish in factory

- Challenges:
  - More labor intensive than other PPVC systems
  - More challenging dimensional control
  - Multistage QA/QC
  - Requires more connections (cost implication)
  - More joints- potential sound transmission issues
  - Stability for transport and erection

- "Concrete Frame Systems", where a basic concrete frame in a 'U' or an 'L' shape is cast, then further flat panels are added to the frame to complete each module.

  - Advantages:
    - Stable units resistant to torsional loads during transport
    - Fast installation
    - Stable once in the building, no need for shoring or propping.

- Can be 85 to 90% completed off site.
- Extremely fast production. Well planned factories can use forms 3 x per 24 hour cycle.
- Very low labor content in the finished building
- Excellent QC/QA
- Extreme design flexibility.
- Excellent insulation and sound transmission characteristics
- Reduced material consumption.
- Excellent dimensional control
- Easy to finish in a factory

- Challenges:
  - Electrical distribution
  - Protection of finishes during transportation
  - For high efficiency needs JIT production to site

- "Vault Systems", used for over 50 years to produce hotels, prisons and other repetitive structures up to 20 floors high which can be finished internally and externally, with or without plumbing and equipped with bathroom and kitchen fittings, easily dispatchable, even over long distances. These structures also have excellent seismic performance and a high quality of acoustic and thermal insulation, greatly reducing the presence of thermal bridges.These units are generally made from very large

Prefabricated pre-finished volumetric construction for a villa project

(L = 6 m-> 9 m, W = 3 m + 6 m, H = 2.6m-> 3.5 m) 5- or 6-sided formwork and generally weigh upwards of 20 metric tons.

- Advantages:
  - Very stable units resistant to torsion loads during transport
  - Easy to install, providing the production and detailing are well thought out
  - The building needs no shoring or propping
  - Can be 90 to 95 % completed off site and easily closed off for protection during transport
  - Fast production and installation
  - Easy sound insultation between floors/ apartments
  - Low labor content in the finished building
  - Good dimensional control
  - Excellent QC/QA
- Challenges:
  - Weight
  - Higher level of concrete consumption (double walls and floors)
  - Design flexibility
  - Difficult external insulation
  - Difficultly in using the same mould/form 2 times per day
  - Final building appearance (less architectural flexibility)

In the last few years, the demand for housing worldwide has grown exponentially, from single luxury villas to multistorey apartment blocks and catering for social housing needs.

The success of a housing project very often depends on the choice of the correct engineering (both structural, architectural and MEP [mechanical, electrical, and plumbing]) and of the best production technology.

Production of free-standing 3-dimensional modules with PPVC technology

The latest trends in PPVC architecture is: maximization of modules span with the optimization of concrete ratio (element thickness), keeping into consideration the need for flexibility in the dimensions of each PPVC unit.

The production technology must integrate the inputs above with the need to maximize the finishing activities within a factory environment in order to reduce construction time.
The best strategy is to create an industrial process in a sector where onsite activities have often been predominant, thus causing long waiting times as well as contingencies and extra costs.

Reduction of manufacturing time as well as more control possibilities can give only advantages to both contractors, producers and more importantly the final users.

PPVC modules are likely to be "plug and play" type, as they should exit the manufacturing process with all the finishes, interior walls, and MEP inside, so that only mechanical dry connections are needed onsite.

The engineering of the building system must be completely integrated in all its parts: architecture design, structure design, MEP layout, reinforcement distribution, concrete mix design are all part of a BIM (Building Information modeling) that grows during all the design phases and keeps track of all the modifications, as it grows. The BIM model with all its attributes must be integrated with the manufacturing ERP(Enterprise resource planning) in order to always have a clear idea of "costs & benefits."

Manufacturing facility must be equipped with "state of the art" technological processes like: 3 dimensional moulds with adjustable parameters that can be modified to suit a range, such as length, width and height of the modules, as well as wall thickness, with a reduced changeover times; circulation lines where raw prefabricated blocks pass through several work "stations" which allow different activities to be achieved, such as external finishes (applications of insulation, cladding), interior finishes i.e MEP installation, doors and windows fitting, tiling, kitchen and bathroom installation and painting.

On-site activities should be limited to dimensional control, modules handling with cranes and fixing. ■

FURTHER INFORMATION

BIANCHI
TECHNOLOGY FOR PRECAST

Bianchi Casseforme srl
Via G. Di Vittorio, 42
43045 Fornovo di Taro (PR), Italy
T +39 (0) 525 400511, F +39 (0) 525 400512
info@bianchicasseforme.it, www.bianchicasseforme.it

STRUCTURAMA
MILAN | BELGRADE | PENZA | MOSCOW | PHILADELPHIA | LODZ

Structurama, Milan
Via Italia, 197
20874 Busnago, Italy
T +39 (0) 39 6095648
www.structurama.com