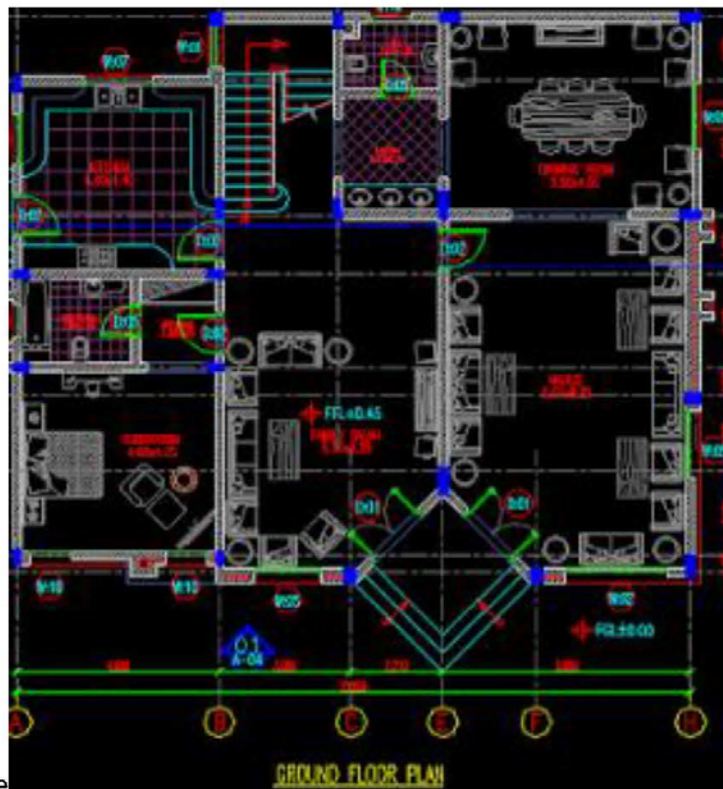


■ VARIOUS TYPE OF IBS SYSTEM

Project Brief (Assumed):

- Number of units each location : 4,000 units
- Type : Two storey semi-detached
- Built up each unit : 300 m2
- Completion period : 4 years (48 months)
- Assume all walls are of precast concrete, external walls of 200mm double walls of 80mm each side with 40mm air-con gap in between, loadbearing wall 140mm, internal partitions 120mm thick
- Assume floor slabs of hollow core slabs of 200mm thick with 2 spans of 8m and 4.8m
- Assume floor to floor height 3.6m with 1m parapet wall above the roof.
- Layout plan as shown attached (party wall on the left):



Mirror image

11.7mx12.8m

■ VARIOUS TYPE OF IBS SYSTEM



Mirror image

11.7m x 12.8m

Factory Capacity:

- Plan centralized factory nearby sites since investment in automated factory is substantial
- Factory set-up 1 year, production period 2.5 years (30 months), installation period also 30 months (3 months behind production), 3 months for final finishing after last installation
- Projected capacity : 1,600 units/year (roughly 135m³/unit)
- Total precast concrete volume : 540,000 m³ (216,000 m³/year or 18,000m³/month or 700m³/day)
- Basic Elements to produce : Walls, Hollow Core Slabs, Stairs, Columns, Beams
- Walls of volume 96m³/unit (71%) or 382,100m³ all in. This will be produced by two automated pallet circulating plants
- Total volume include hollow core slabs of total project 1,200,000m² (480,000m²/year or 40,000m²/month or 1,540m²/day) or 124,260m³ (23%). This will be produced in a dedicated hollow core factory.
- Balance volume of 33,640m³ (6%) of stairs, beams and columns to be produced by another factory with fixed moulds
- Another covered area will be utilized for rebar cut & bend, fix and tie the caging for the RC plant. Other miscellaneous works can also be done here.
- Factories to be covered for all weather protection, Stockyard open

■ VARIOUS TYPE OF IBS SYSTEM

- Factory to be demountable so that it can be shifted to another location should the need arise



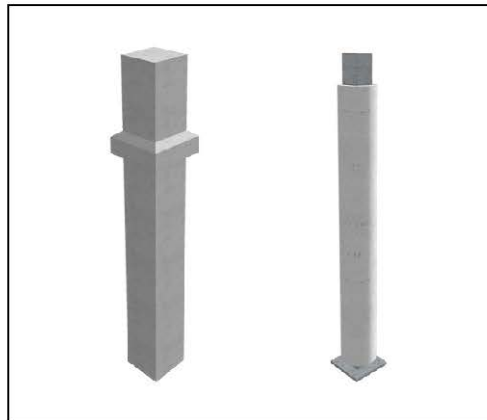
Precast Walls



Precast double walls



Hollow Core Slabs



Precast Columns



Precast Staircases



Precast Beams

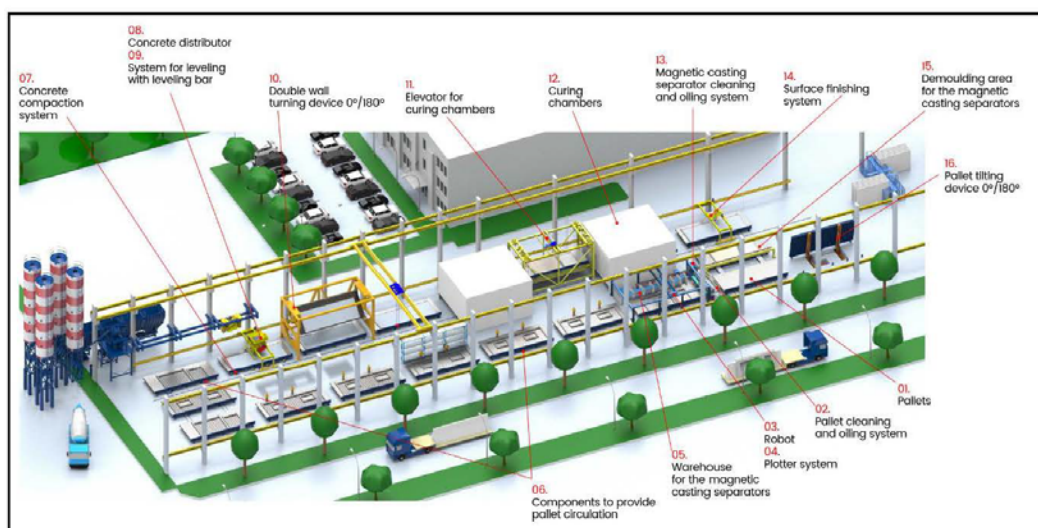
■ VARIOUS TYPE OF IBS SYSTEM

Construction Methods:

- Precast elements (basic elements of walls, hollow core slabs, columns, beams, staircases) to be assembled at the site with no slab topping. Only grouting to structural connections and shear keys of hollow core slabs are required on site. Some structural ties need to be added to shear keys and cores of hollow core slabs before grouting. Good waterproofing membrane and waterproof screed is required especially on the roof. MEP services, architectural finishing and infrastructure works are to be carried out at the site.

Production Systems:

- State-of-the-art robotic factory with carousel/pallet circulation plant to be set up for wall panel production including those double walls. For the hollow core slabs, long line prestressing method to be deployed with extruders to be used. Odd elements like walls with protrusions, staircases, beams and columns to be manually cast in another factory. The individual precast elements like wall panels, hollow core slabs, staircases, columns and beams will be stored at the stockyard and later transported to the site and installed.
- Design information will be transmitted digitally via the factory computers to direct the machines/robots in performing the production activities. The batching plant will also be linked digitally and production reports will be available for reference and analysis.



Pallet Circulation Plant

■ VARIOUS TYPE OF IBS SYSTEM



Long line Hollow Core Slabs production

Factory Details

- Estimated land area : 20 hectares (50 acres)
- Covered factory area : 26,000 m²
- Stockyard area : 50,000 m² (If production is well ahead of site work, the elements will be delivered and spread out at the job site). Wall elements to be stored vertically in racks.
- Other ancillary buildings: Factory office, store, workshop, labor quarters, substation, canteen, batching plant, air compressor room, etc.
- Facilities in factory: -Carousel/pallet circulating plant with 2x60 pallets in two carousels and two cycles per day (each pallet on average 2.5 panels)
-10x150m long lines for hollow core slabs production, 3 sets extruder
-Moulds for walls with protrusion, beams, columns & staircases
- Batching plant : Either 3 nos. 2.0m³ or 4 nos. 1.5m³ pan mixers complete with chiller/ice flake machine and flying buckets on tracks
- Capacity per day : 700 m³ (Approximately 5 to 6 units per day)
- Estimated labor force in factory : 450 pax in two extended shifts (may need more initially due to longer learning curve for highly mechanized plant).

■ VARIOUS TYPE OF IBS SYSTEM

- Estimated set up cost : USD50 million
- Time for factory set-up : 12 months

Site Installations

- Estimated quantities per unit :
 - Wall panels = 80 nos.
 - Staircases = 4 nos.
 - Columns = 3 nos.
 - Beams = 5 nos.
 - Hollow core slabs = 300 m2
- Total quantities for 4,000 units :
 - Wall panels = 320,000 nos.
 - Staircases = 16,000 nos.
 - Columns = 12,000 nos.
 - Beams = 20,000 nos.
 - Hollow core slabs = 1,200,000 m2
- Assume installation speed :
 - Wall panels, Columns = 14 nos./team/day
 - Staircases = 20 nos./team/day
 - Beams = 15 nos./team/day
 - Hollow core slabs = 350 m2/team/day
- Total installation period based on total quantities = 29,276 team-days
- Installation period allowed = 30 months (780 days, exclude Sundays)
- Number of Installation crane/teams = 38 (Total 228 pax)
- Weight of heaviest element : 8.1 mt (double wall panel)
- Type of cranes used : Crawler/mobile cranes of various capacities to suit
- Crane capacity : To be decided upon detailed precast layout design



Double wall installation



Wall installation

■ VARIOUS TYPE OF IBS SYSTEM

Suggestions for Improvement

- Consider casting of volumetric modules (using three dimensional system forms, adjustable type if possible) instead of individual wall and slab panels, but with MEP services and architectural finishes done insitu. The bathroom units can be fully prefabricated, complete with MEP and finishes in a separate factory.
- One step further will be to prefabricate the whole volumetric modules in the factory complete with finishes. Installation will be faster but with bigger cranes. MEP and finishes will be done in the factory with less wastages and pilferage. However, space needed for the factory will be very large due to storage space requirement.
- Accuracy of figures can be improved upon more information become available



Volumetric Modules