Monolithic Concrete Construction using Plastic/ Aluminium Formwork

Figure 01: Framework and pipelines

Figure 02: Multi-story high rise project in NCR

Overview

In the monolithic concrete building system, walls and slabs are cast in one operation in specially designed light weight form/molds of aluminum in concrete. Concrete is poured in the forms & forms are removed after the setting of concrete takes place. The predesigned formwork also acts some sort of assembly line production and enables rapid construction of multiple units of repetitive type. In monolithic concrete construction with aluminum forms system, concrete walls and slabs are cast monolithic at one pour and are considered as shear wall construction. The system allows reduction in thickness of concrete members below the minimum value than the conventional natural resources. This system reduces the cost of repair and maintenance compared to conventional system. The panels of aluminum formwork are made from high strength aluminum alloy, with the face or contact surface of the panel, made up of 4mm thick plate, which is welded to a formwork of specially designed extruded sections, to a form a robust component. The panels are held in position by a simple pin and wedge arrangement system that passes through holes in the outside rib of each panel. The panels fit precisely, securely and require no bracing. The walls are held together with high strength wall ties, while the decks are supported by beams and props. As capital investment in aluminium formwork is high, this may not be economical for small project of less than 500 units. Minimum 100 repetitions are desirable. List of major completed projects:

1) 5008 No. of houses at Kanjhawala Narela, Delhi for DSIIDC. 2) 512 No. of houses in Bawana, Delhi for DSIIDC. 3) 3000 houses in Ahmedabad for Ahmedabad Municipal Corporation at Ahmedabad. 4) 3000 houses in Lucknow for Lucknow Development Authority & other project in major Indian Cities.

Resource Efficiency	**Embodied energy and CO_2 emissions**	EE: 1184.4 MJ/kg CO_2 Emissions: 50.16 kgCO_2/m^2 **As the material is light weight and recyclable, energy savings can be made over the lifetime of the metal's use.*	*Source: Calculations based on material specifications. India Construction Materials Database of Embodied energy and Global Warming Potential*
	Critical Resource Use	57.8	*Source: Calculation based on criticality index (0-100)*
	Current Recycled content	Nil	
	Future reusability	High. Aluminum is recyclable and its formwork has high reuse potential (>100 times)	*Source: Technology profile of monolithic concrete construction system using aluminum formwork, BMTPC*

	Water use during construction and manufacturing	301.5 Litres/m^2	*Source: Calculations based on material specifications.*
Operational performance	**Durability**	High: If built according to IS 456	*Source: Compendium of prospective Emerging Technologies for Mass Housing, Second Edition, BMTPC, April 2017*
	Ease and frequency of maintenance	Low frequency of maintenance	
	Impact on cooling or heating loads	Cooling energy (kWh/m^2/y) savings under different climatic zones Composite: -4 (-8%) Warm & humid: -1.31 (-3%) Hot & dry: -6.22 (-13%) Temperate: -2.92 (-19%) Heating energy savings in cold climate: -22.8 (-54%)	*Source: Based on simulations. Values in savings from base case: 225mm solid burnt clay brick with 12.5mm plaster on both sides.*
	Noise transmission	Avg. sound reduction for 100 mm concrete is ≥ 45db	*Source: Interview with Ashok B. Lall Architects*
	Thermal mass (absorption, storage and release of heat)	288.2 kg/m^2	*Source: concrete density value*
	Thermal performance (flow of heat)	U-value 3.59 W/m^2k for 100 mm RCC Walls and Roof	*Source: Technology profile of monolithic concrete construction system using aluminum formwork, BMTPC*
User Experience	**Familiarity with the material**	Low	
	Modification ability	Low: Post construction modifications are not possible	*Source: PAC Formwork for Monolithic Construction, BMTPC, 2011*
Economic impact	**Cost of construction**	INR 15,515/m^2 of built up area (To achieve economy, minimum 100 repetitions are desirable.)	*Source: Proposal for Kerala Flood Relief Homes, Ela consultancy & EMC Kerala, 2018*
	Skill requirement	Low: Installation guidelines required for the formwork system shall be supplied to the semiskilled and unskilled workers	*Source: PAC Formwork for Monolithic Construction, BMTPC, 2011*
	Supply chain	Medium: Manufacturing is currently centered around major cities only, where large scale housing projects are under construction.	*Source: Interview with BMTPC*
	Duration of construction	70m^2/day: A lead time of about 3 months is required for initiation of work.	*Source: Interview with Ashok B. Lall Architects*
	Job creation	1 man-day/m^2	*Source: Interview with Ashok B. Lall Architects*