Introduction to Engineered Formwork

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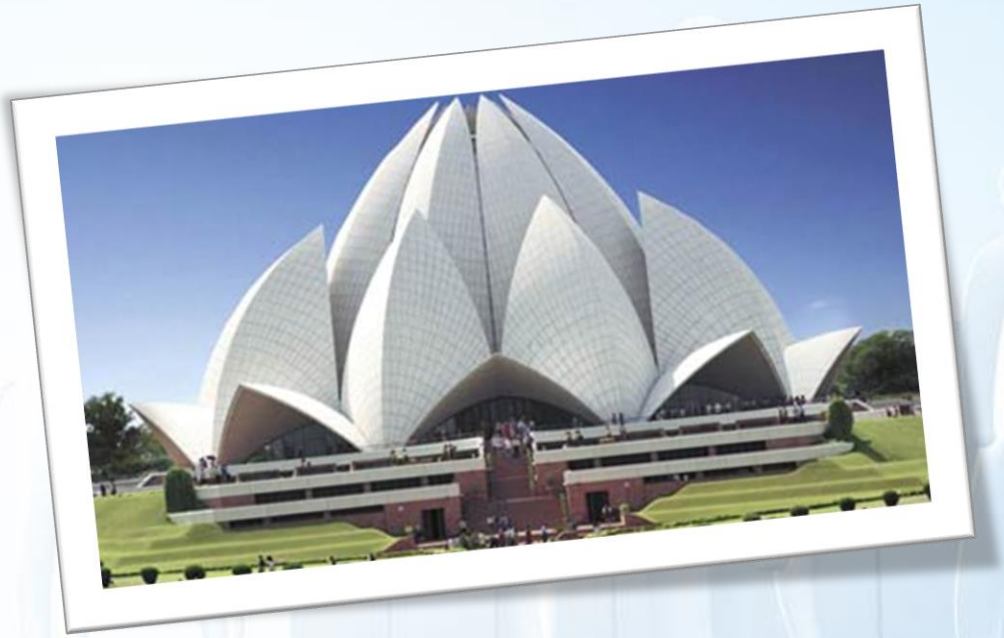
Flow of the presentation

- What is Formwork & why is it so important ?
- Basic materials used in Formwork
- Conventional Formwork Vs Engineered Formwork
- Multiple Engineered Formwork Systems
- A brief on Formwork design
- Check points for Safe & Quality Formwork execution

What is Formwork ?

Formwork is a die or mould used to shape the concrete and support the concrete until the concrete attains sufficient strength to carry its own weight.



- 15-20% of Structural Cost
- 70% of Structure duration

What makes a good formwork system & why is to so important ?

- Speed at which Formwork can be assembled & then dissembled
- Quality of the concrete surface finish
- Flexibility of the materials
- Safety of the workmen
- Optimum use of Labour & Materials
- Enabling faster construction
- Overall contribution towards cost savings

Basic materials used in Formwork

- **Plywood** -- > Mainly used as a sheathing member
- **Timber** ----> Used as a primary support to Ply (Conv. FW)
- **H-Beam** ---> Used as a secondary as well as primary support to Ply
- **Structural Steel**
  - (a). Heavy weight – Requires machineries for handling
  - (b). Higher investment cost
  - (c). Higher reusability – Can be repeated as much as 50 times
- **Aluminum / Plastic**
  - (a). Light weight – Best suited for manual handling
  - (b). Higher investment cost
  - (c). Greater reusability – Can be repeated as much as 200 times

Evolution in Vertical Formwork

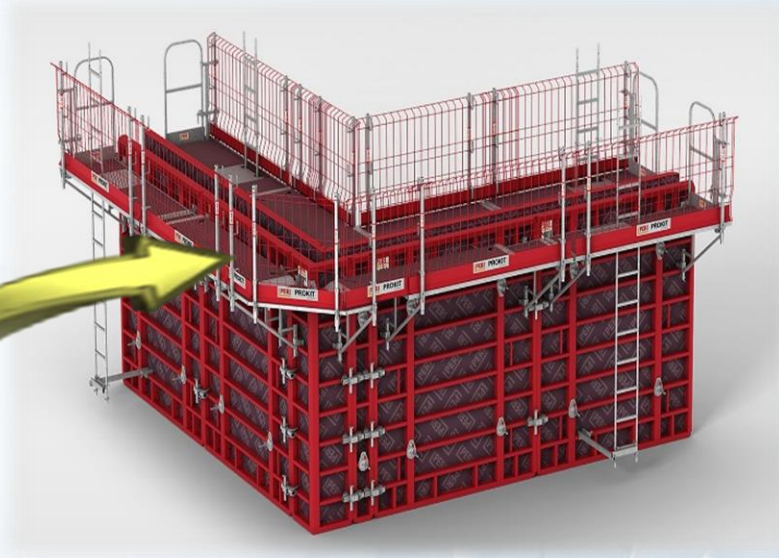
Productivity in Sq.m / MD : 1.5 ➔ 3.0 ➔ 5.0

Tower crane dependency : No ➔ Yes ➔ No

Conventional

Systematic Conventional

Modular

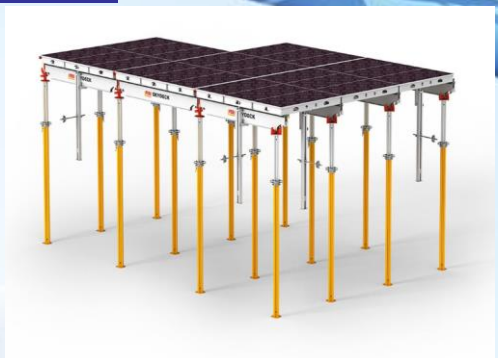


Evolution in Horizontal Formwork

Productivity in Sq.m / MD : 1.5 → 3.0 → 6.0

Tower crane dependency : No → Yes → No

Modular



Systematic Conventional

Conventional

Comparison b/t Conventional Vs Engineered Formwork

CONVENTIONAL	PARAMETER	SYSTEM/ MODULAR
HIGH	SKILLNESS REQ	LOW
LOW	LABOUR OUTPUT	HIGH
VERY HIGH	CONSTRUCTION TIME	LOW
HIGH	LABOUR DENSITY	LOW
LOW	LOAD BEARING	HIGH
LOW	PRODUCT FINISH	HIGH
VERY LOW	SAFETY	HIGH
LOW	MATERIAL REUSABILITY	HIGH
LOW	INVESTMENT COST	HIGH (Economical in longer-run)

Typical Formwork Material Mobilization Strategy

PROJECT NAME: XYZ	Structural Config : B+G+5 Typ Floors			Structural Duration : 8 Months		Tentative Material Estimate							
RC Structure	FW Scope of Work (Sqm)	Formwork System	Duration of work (Months)	Cycle Time (Days)	Planned area to be Mobilized (Sqm)	Steel		H-Beam		Plywood		Aluminum	
						Consumption (Kg/Sqm)	Total req. (MT)	Consumption (Rmt/Sqm)	Total req. (Rmt)	Factor (for wastage)	Total req. (Sqm)	Factor (for modification)	Total req. (Sqm)
Raft & Footing	1,500	AL FW	1.0	4	231	20	5	-		-	-	1.10	253.85
Columns	4,200	AL FW	7.0	5	115	25	3	-		-	-	1.15	132.69
Shear Wall	7,100	AL FW	7.0	5	195	30	6	-		-	-	1.15	224.31
Slab & Beam	25,000	Flex + HDT	7.0	20	2,747	70	192	6	16,484	1.10	3,022	-	
Staircase	3,000	Flex	7.0	20	330	80	26	7	2,308	1.25	412	-	
Retaining wall	2,100	AL FW	3.0	6	162	25	4	-	-	-		1.10	177.69
Total FW scope:	**42,900**	**Total qty of FW to be mobilized :**			**3,780**		**236**		**18,791**		**3,434**		**789**

Planned area to be mobilized = Total Scope/ ((No of workings days/Month X Total Duration in months) / Cycle Time in days)

Factors influencing Column/Wall Formwork Design

(a). Height of the Concrete pour

(b). Rate of pour of concrete

(c). Workability of the mix, Slump

(d). Concrete temperature

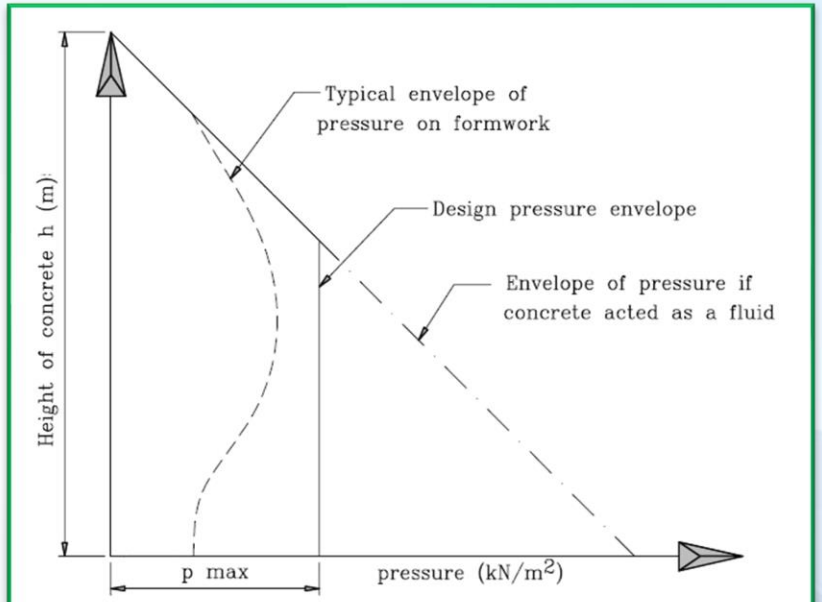


Figure 1 Design Pressure Envelope

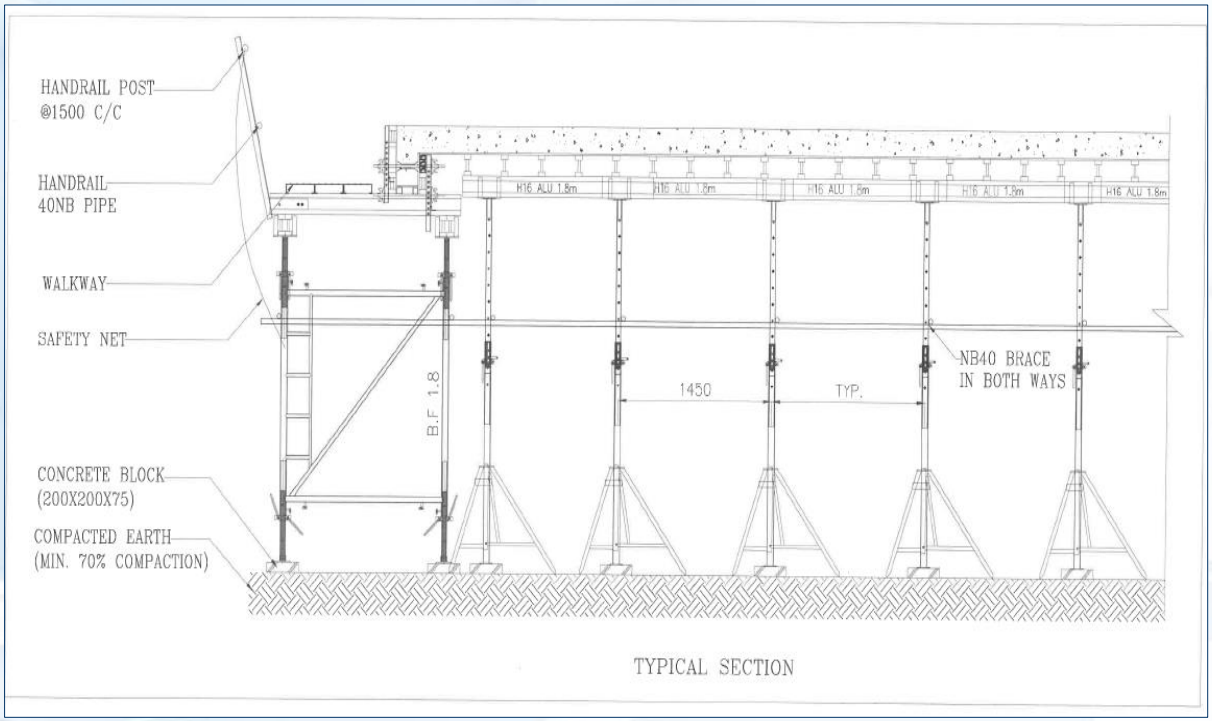
$$P\max = D\,(C1\,\sqrt{R} - C_2\,R\sqrt{}\,(H\text{-}C_2\,\sqrt{R1}))\ \text{or}\ Dh\ \text{kN/m}^2\ \text{whichever is less.}$$

Factors influencing Slab/Beam Formwork Design

(a). Weight of reinforcement steel & fresh concrete ---- > D X 25 Kn/m2

(b). Self-weight of the Formwork --- > B/t 1.0 – 1.5 Kn/m2

(c). Various live loads imposed during concreting ---- > B/t 1.5 – 2.0 Kn/m2



Formwork alert points for Slab & Beam Formwork

1. Ensure the availability of GFC Scheme prior to start of job.
2. Material quality to be ensured prior to use.
3. Ensure firm base i.e either Concrete Slab/PCC (75mm min)/Concrete Pads of min size (250mm X 250mm x 75mm)
4. Ensure re-propping is provided for below floors, as per scheme.
5. Ensure 100% CT Props are supported with Folding Tripods & inter-connected with later bracings
6. Ensure staging assembly is connected to a nearby permanent structure like Column, Shear Wall etc.,
7. If working on a Flat Slab, ensure Column Capital section is closed with Plywood, prior to moving to other parts of Slab.
8. Critical accessories like CT Prop Locking Pin or HDT Spring-Lock Pins are provided as per the SOP.
9. Ensure all check-list points are attended & found to be ok, prior to proceeding to next stage.
10. During concreting, it is to be dispersed evenly without allowing it to heap.
11. Ensure to follow de-shuttering, re-propping & fall protection guidelines

Why Re-Propping Is necessary ?

Sl. No.	Type of Formwork	Minimum period before striking of formwork
1	Vertical formwork to columns, walls, beams	16 – 24 hours
2	Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)	3 days
3	Soffit formwork to beams (props to be refixed immediately after removal of formwork)	7 days
4	Props to slabs: 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	 7 days 14 days
5	Props to beams and arches: 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	 14 days 21 days

EXCEL Sheet example

showing Re-propping design calculation

Quality checks in Aluminum Formwork

AL FW Checklist

Tower No:- Floor No:- Pour Card No:- Date:-

CHECK LIST FOR FLASH POINTS OF ALUMINUM FORMWORK SYSTEM

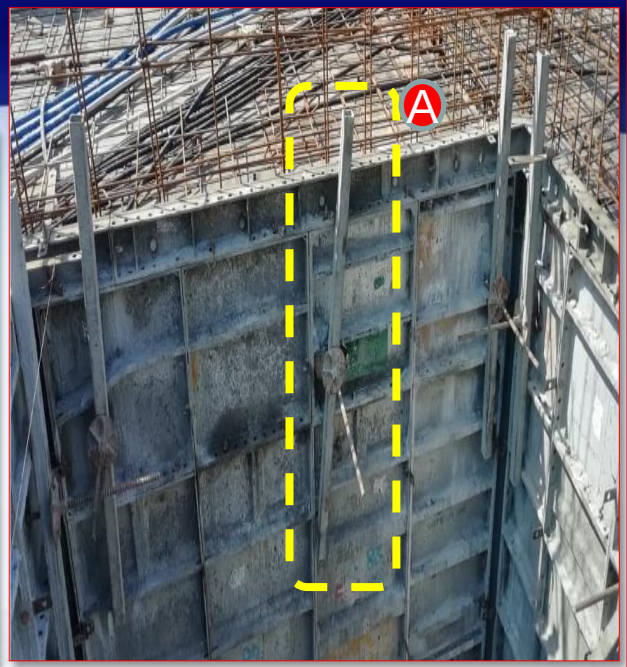
SL NO	DESCRIPTION	YES	NO	Remarks
	KICKER ARRANGEMENT:			
1	Check whether every Kicker-hole is provided with a Bolt			
2	Check whether every Kicker panel joints are connected by Pins and wedges in horizontal as well as Vertical direction.			
3	Check whether Kickers are supported by Vertical soliders by max of 1m c/c as per the wall brackets.			
	WALL PANEL ARRANGEMENT:			
1	Check whether right angles are provided at min two levels in every corner of inside wall.(300mm & 1500mm from bottom respectively)			
2	Check whether the Wall Std Panel is bolted to Wall Top			
3	Check whether min 7 Nos of Wall-Ties have been provided in any given single wall side.			
4	Check whether additional Wall Tie grooves are either filled/plugged with PVC			
5	Check whether each Wall Panel joint is provided with an alignment Turn-buckle/Alignment Square tube.			
	SLAB PANEL ARRANGEMENT:			
1	Check whether props are provided below the concreting floor. (Prop should not disturb while de shuttering/Left in prop.)			
	BUILDING SPACER ARRANGEMENT:			
1	Check whether Building spacers are provided in lift, staircase and open to terrace areas where ever possible.			
	SLURRY LEAKGES ARRANGEMENT:			
1	Check whether GI sheet of 200 mm projection provided throughout the building periphery.			
2	Check whether Tarpaulin was covered on adjustable walkway throughout the building periphery including lift shafts			
	COMMON ARRANGEMENT:			
1	Check for dent Panels. If present, whether replaced,			
2	Check whether Panels are cleaned on all the sides before fixing.			
3	Check whether Post concrete inspection in the previous floor and corrections carried out in the pour.			

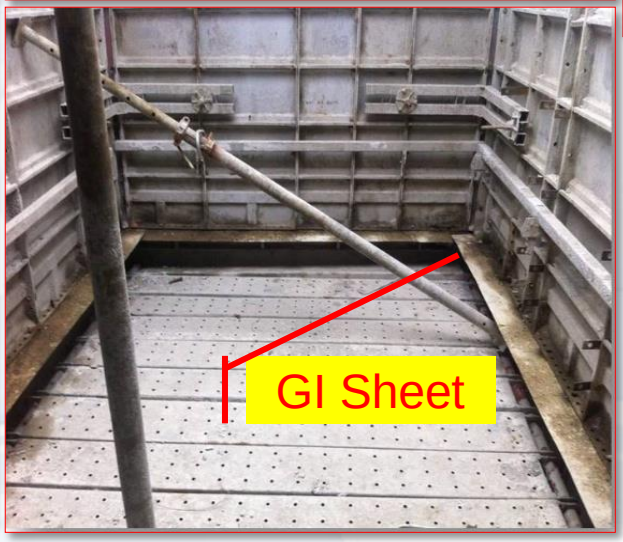
Note: - Servicing of All Aluform panels to be done @ every 5th Use.

Site FW Head Tower In-Charge Quality In-Charge Y / N

Is the pour cleared? ☐☐

Construction manager





For improved quality, additional measures

Pt (A) To ensure that the Kicker Junction area is unmoved, vertical soldier support at 1m C/C (connecting Wall Panel to Kicker) was introduced.

Pt (B) To ensure 100% right angle at Corners, L Shaped fab members are provided at min of 2 lvls.

Pt (C) To Prevent the Concrete Slurry from rolling down on to the below floors, GI Sheets are introduced right at the bottom of the Panels. In addition, Tarpaulins are also spread over the external Working Platform for slurry collection.

THANK YOU

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