

Agenda

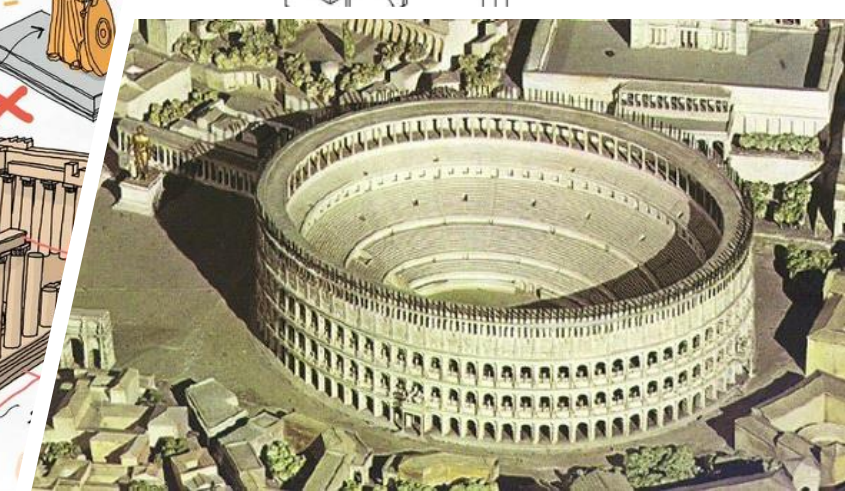
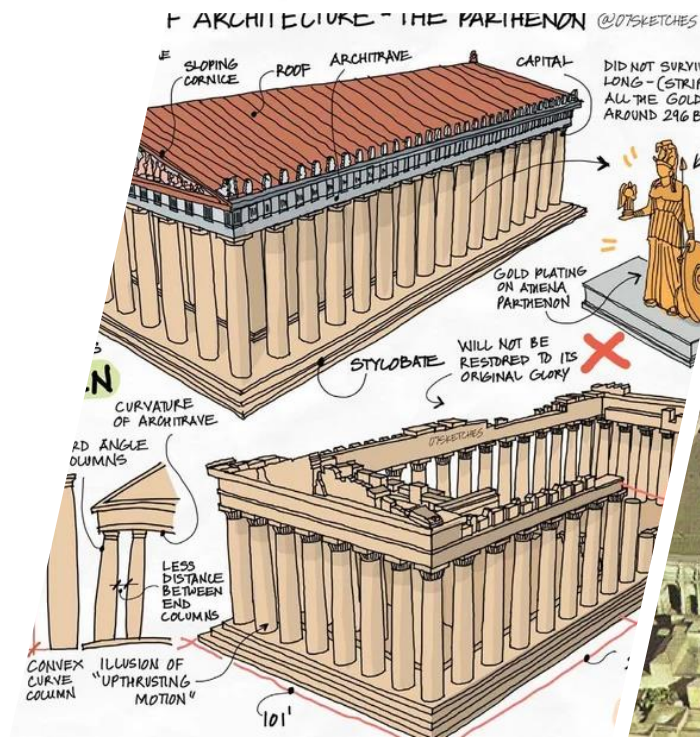
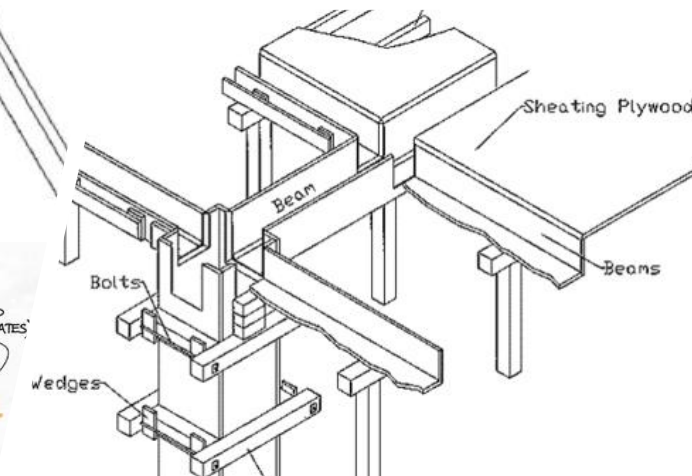
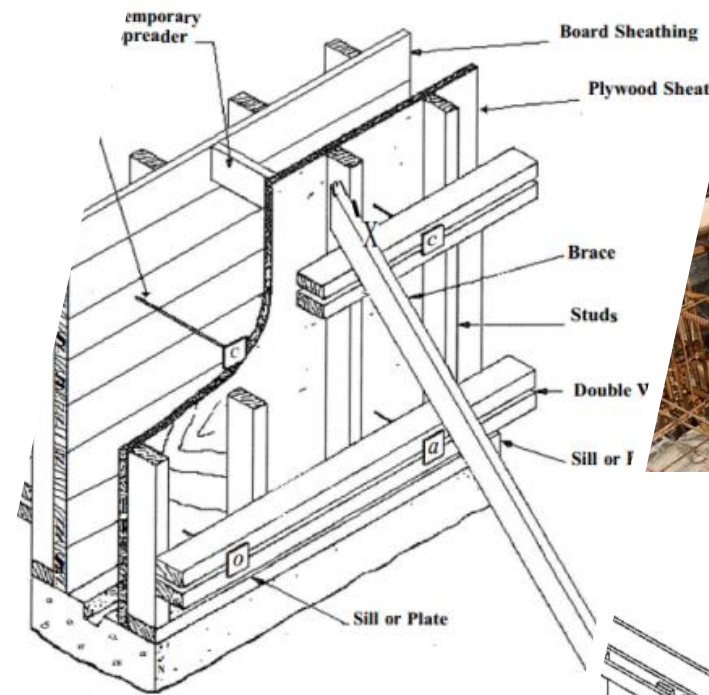
1. Fundamentals of Formwork
2. Comparison of Conventional & Engineered formwork
3. Some Thumb rules
4. Formwork management
5. Safety Aspects
6. Practical Case studies
7. Some Large Scale Project referneces with Special formwork systems



FUNDAMENTALS OF FORMWORK

What is Formwork

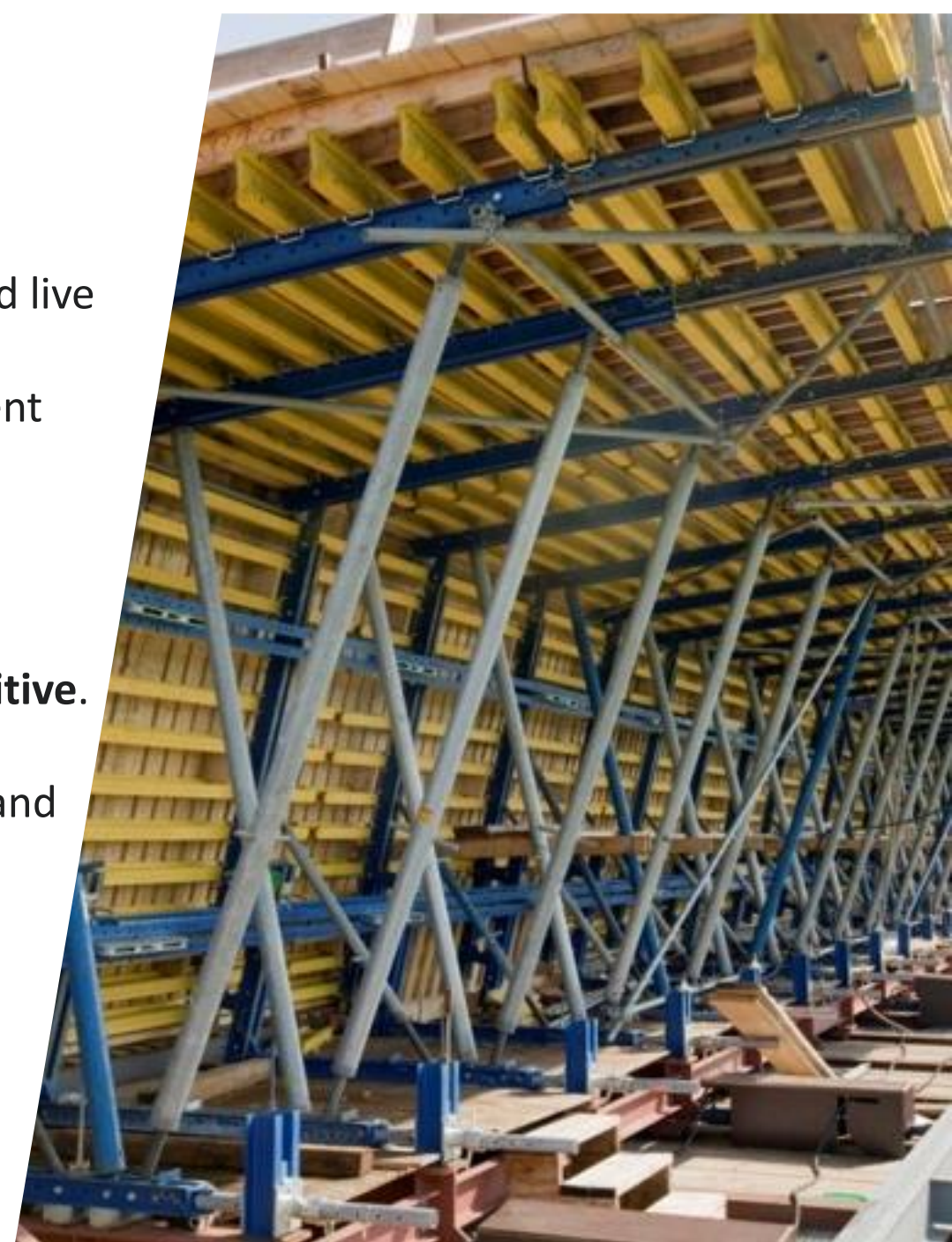
- ❖ Form work is basically a temporary mold to shape green concrete till it attains the required strength.
- ❖ The first Formwork possibly used during Construction of the Parthenon & the Colosseum in the ancient Roman Civilization during 25 to 50 AD.



Fundamentals of Formwork.

Key requirements of a suitable Formwork

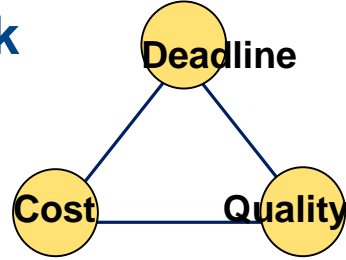
- ❖ It should be **strong enough** to withstand variety of dead and live loads.
- ❖ The joints in the formwork should be **tight enough** to prevent leakage of cement slurry.
- ❖ The formwork should be **easy on assembly & disassembly**
- ❖ The material of the formwork should be **durable and repetitive.**
- ❖ The surface of the formwork should be **plain and smooth**, and set properly to the desired line and level.
- ❖ It should be an **engineered product.**
- ❖ It should be **non reactive to chemical hydration** process of cement .
- ❖ It should offer **safe working space.**



Fundamentals of Formwork.

Selection criteria of Formwork

- ❖ The type of RCC structure
- ❖ Formwork Height
- ❖ Floor to Floor height & slab thickness.
- ❖ Pouring method and concrete pressure.
- ❖ Site conditions....
- ❖ Availability of machineries and equipment.
- ❖ Safety requirements.
- ❖ Numbers of re uses planned.
- ❖ Availability of skilled manpower



COMPARISON BETWEEN TRADITIONAL & SYSTEM FORMWORKS

SL NO.	PARAMETERS	CONVENTIONAL	SYSTEM FORMWORK
1	Durability	conventional systems are less durable	Durable if compared to conventional systems
2	quality	Quality of materials are inferior	Quality of materials are superior
3	productivity	conventional systems are less productive. More components are required per sqm.	System formworks are highly productive and less number of components are required in a particular area.
4	Handling	material handling is time consuming and indefinite. The components are highly liable for lost and damage.	material handling is well planned and easy. The components are less liable to be lost or damaged.
5	strength	Strength of materials are sometimes known or unknown and applications are on trial & error	Strength of materials are always known and applications are well calculated and
6	Repetitions	less repetitive	Highly repetitive (from 50-500 times depending upon various systems)
7	workability	conventional systems are less workable and time consuming but easily available in the local market. Ease of work is not guaranteed.	system formworks are highly workable and enhance the productivity.
8	Initial cost	Initial cost is low but at the end of the project the total cost may be more	Initial investment is high but the total cost will be well amortized in one or more number of projects
9	Safety aspects	conventional systems are not available with safety requirements	system formworks are highly safe and well designed.
10	Assembly/ Dissassembly	Assembly Disassembly of conventional systems are not planned and sometime not required prior to any job.	Assembly / Dissassembly is well planned and safe, required prior to fix at site. Components are not damaged.



Type of Formworks based on materials

Based on Materials

1. *Timber formwork*
2. *Steel Formwork*
3. *Plastic formwork*
4. *Aluminum Formwork*
5. *Composite formwork*



Type of Formworks based on Application

Based on Applications

1. *Wall Formwork*
2. *Slab Formwork*
3. *Climbing formwork*
4. *Shoring & Scaffolding Systems*
5. *Safety Systems*

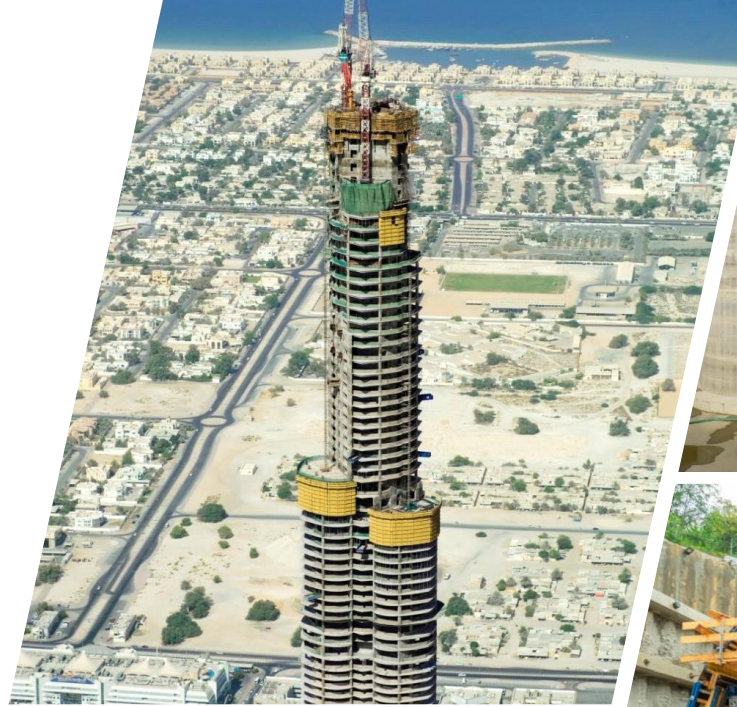


Special Formworks

Based on construction methods

1. *Automatic Jump Formwork*
2. *Movable scaffolding systems*
3. *Form Traveller & Balance cantiliver*
4. *Tunnel formwork-infra*
5. *Slip Formwork*
6. *Monolithic wall-slab concreting with metal or Plastic formwork systems*

Etc.



Fundamentals of Formwork.

Some Thumb rules

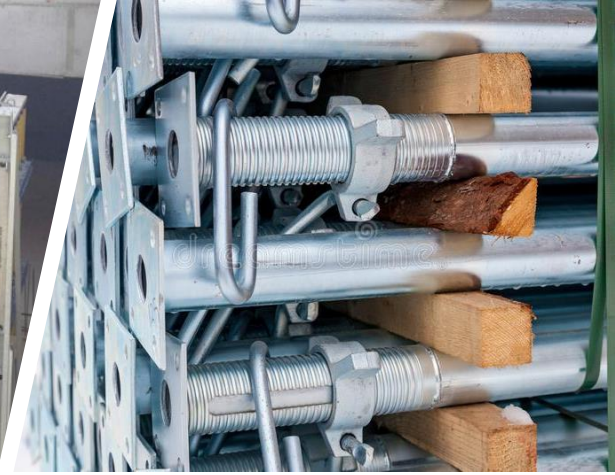
1. Formwork cost would vary from 8% to 20%
2. Flex 1-2-4 arrangement for slab
3. Timber beam H20, 3.5 rm. per sqm. In slab formwork
4. Raw timber need 1.5 cft. per sqm. In slab in slab formwork
5. Traditional productivity 1sqm/man-hour for slab formwork
6. Timber H20 beam 4rm per sqm. In wall formwork
7. Monolithic formwork productivity is 3sqm/man-hour.



Fundamentals of Formwork.

Formwork management

1. *Engineered Formworks are asset to any construction company and they should be managed properly*
2. *Inventories must be counted periodically*
3. *All Formwork components must have periodical maintenance.*
4. *Formwork Manager must check stock out and stock in and asset allocation*
5. *Training should be given to workers time to time.*
6. *Formwork manager must plan for any project with existing materials first*
7. *Wooden components like timber beams, plywood , etc. must be kept under cover.*
8. *For big construction companies a Formwork management team is must.*



Fundamentals of Formwork.

Challenges of Raw timber formworks

1. *Sensitivity to moisture*
2. *Light weight and low repetitions*
3. *Less Durable.*
4. *No uniformity & low in strength.*
5. *Wastage is more*
6. *Risk of accidents involved.*
7. *Lack of replantation will endanger eco system and may increase carbon in the environment.*



Fundamentals of Formwork.

Holistic and sustainable safety in formwork

Doka takes the holistic approach to safety.

Safety starts with product development, extends over a wide-ranging portfolio of safety products and services and safety training in the field, through to safety features integrated directly into the systems.

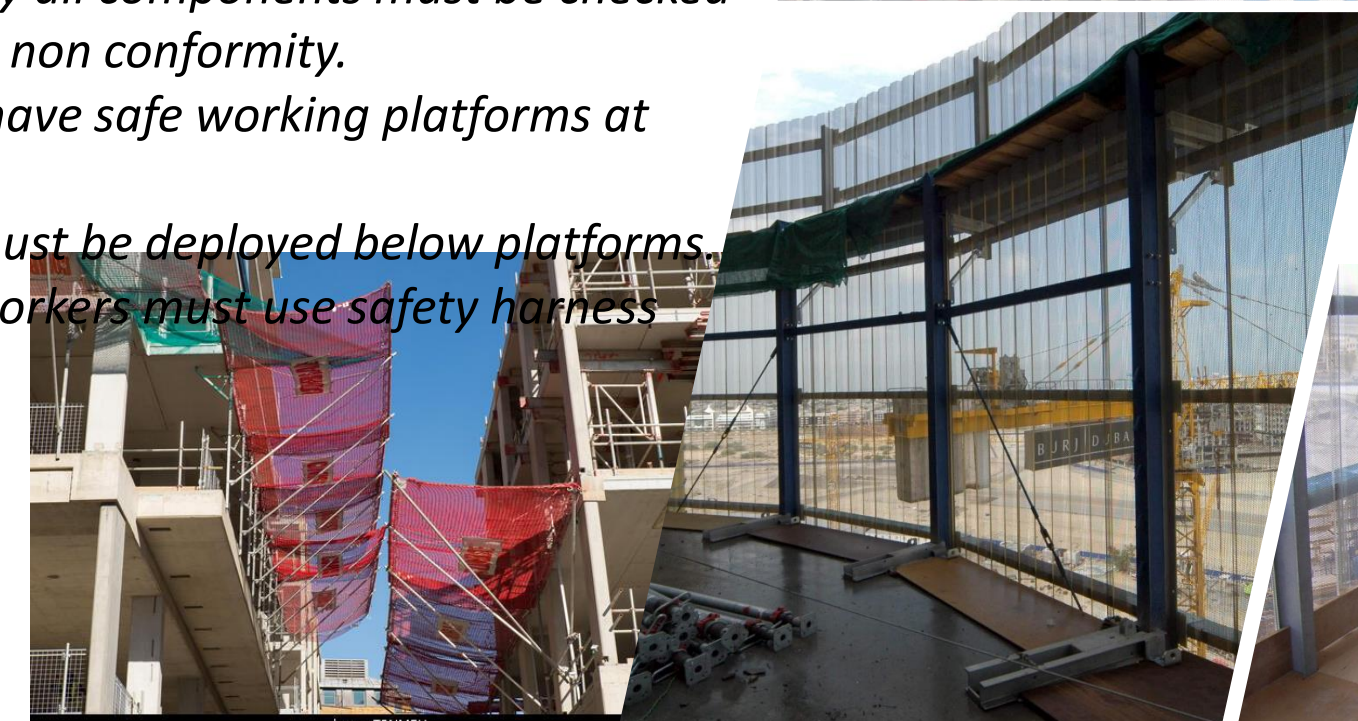
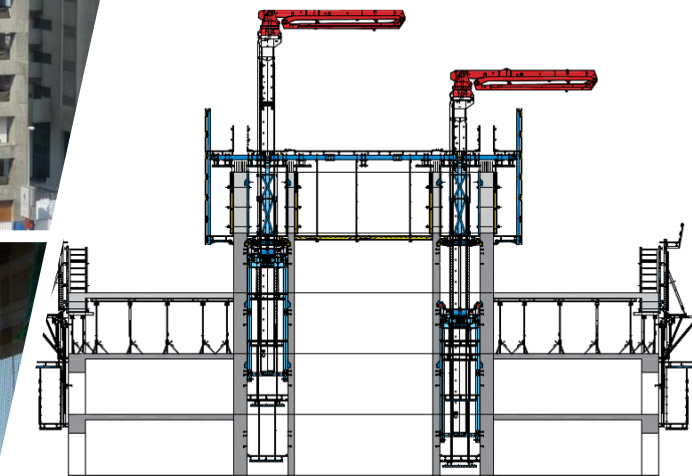
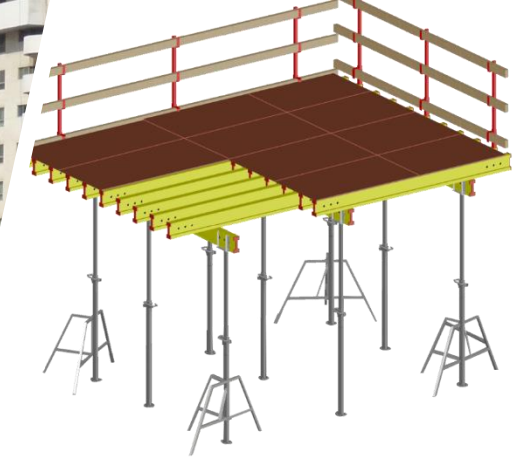
Xsafe stands for safety solutions that are easy to integrate. They help construction workers get the job done while at the same time protecting their health and keeping the jobsite as safe as possible. Because as well as boosting motivation and crew well-being, safety also has a long-term benefit on productivity and demonstrably enhances the cost-efficiency of any project: **Every investment that improves safety brings a factor 2.2 ROI.**



Fundamentals of Formwork.

Safety of formworks

1. All the components must be designed for safe working load
2. All open edges at height must be protected with hand rail posts & railing.
3. All props and shoring must be vertical and laterally braced when needed.
4. At heights building periphery must be protected.
5. Before assembly all components must be checked for damages or non conformity.
6. Workers must have safe working platforms at heights
7. Fall arresters must be deployed below platforms.
8. All formwork workers must use safety harness



CASE STUDY
D3 vs Cuplock



D3	Cup lock
0.45 parts per cubic meter (- 81%)	2.26 parts per cubic meter
+ 7.53 kg per cubic meter (- 45%)	- 13.78 kg per cubic meter
+ 0.023 manhours per cubic meter (- 63%)	- 0.062 manhours per cubic meter
Comprehensive assembly	Can be assembled incorrectly
+ Max. leg load of 94 kN (+ 51%)	Max. leg load of 40 kN
Horizontal assembly possible	No horizontal assembly possible
Easy horizontal and vertical shifting	Almost no shifting possible
Hot dip galvanized components	Outside painted components
Less flexibility due to the frame system	Very flexible in horizontal adjustment
No further applications	Further applications
Heaviest part 33.7 kg (+ 105%)	Heaviest part 16.4 kg
Doka d3 weighs ~ 7.53 kg per cubic meter. (based on a sample decking area)	Cuplock weighs ~ 13.78 kg per cubic meter. (based on a sample decking area)
<i>This is 45 % less than Cuplock.</i>	
Doka d3 requires around 0.023 manhours per cubic meter to assemble.	Cuplock requires 0.062 manhours per cubic meter to assemble
<i>This is 63 % faster than Cuplock</i>	



Some Large Scale Project References.

Strombrückenzug Magdeburg

Magdeburg, Germany

Type of structure: **A-shaped pylon**

Construction work by: **Hochtief Infrastructure GmbH**

Structure data

- Height: 63 m
- Casting sections: 10
- Inclination: 3.8 degrees

Products used

- Automatic climbing formwork SKE100 plus
- Large-area formwork Top 50

Services

- Engineering, Formwork instructor, DokaXact



Pelješac Bridge

Klek, Croatia

Type of structure: **Tower pylons**

Construction work by: **China Road and Bridge Corporation**

Structure data

- Pylon height: 98 m
- Span: 285 m
- Overall length: 2,404 m
- Cycle time: 7- to 10-day cycle
- Casting sections: 24

Products used

- Large-area formwork Top 50
- Automatic climbing formwork Xclimb 60

Services

- Formwork planning, Formwork instructor



RA217 Nawaseeb Road

Kuwait City, Kuwait

Type of structure: **In-situ cantilever bridge**

Construction work by: **Freysinnet**

Structure data

Main bridge:

- Length: 470 m
- Span: 110 m
- Casting sections: 84

Ramp bridge:

- Length: 893 m
- Span: 95 m
- Casting sections: 132

Products used

- Cantilever forming traveller (CFT)
- Large-area formwork Top 50
- Load-bearing tower d3
- UniKit tower

Services

- 3D formwork planning with DokaCAD for Revit, Formwork instructor



Astfjordbrua Bridge

Trøndelag, Norway

Type of structure: **Composite bridge**

Construction work by: **Metrostav NU**

Structure data

- Length: 800 m
- Width: 11.1 m
- Length of each casting section: 25 m
- Cycle time: 1 week

Products used

- Composite forming carriage

Services

- Formwork instructor



Hisingsbron Bridge

Gothenburg, Sweden

Type of structure: **Composite bridge**

Construction work by: **Skanska-MTH Hisingsbron HB**

Structure data

- Length: 350 m

Products used

- Composite forming carriage
- Bridge formwork ParaTop

Services

- Formwork instructor



Hudson Yards

New York City, USA

Type of structure: **Highrise**

Construction work by: **Cross Country Construction, Roger & Sons Concrete, W&W Steel**

Structure data

- Height: 237 to 395 m
- Number of storeys: 51 to 92

Products used

- Protection screen Xclimb 60
- Table lifting system TLS
- Super Climber SCP
- Framed formwork Frami Xlife
- Load-bearing tower Staxo 100

Services

- Formwork planning, Formwork pre-assembly, Formwork instructor



Burj Khalifa

Dubai, United Arab Emirates

Type of structure: **Highrise**

Construction work by: **Joint Venture Samsung, Besix, Arabtec**

Structure data

- Height: 830 m
- Height of each casting section: 3.7 m
- Number of storeys: 160
- Casting sections: 180

Products used

- Automatic climbing formwork SKE100
- Protection screen Xclimb 60
- Large-area formwork Top 50
- Stair tower 250

Services

- Formwork planning and coordination, Site logistics, Formwork pre-assembly on site, Formwork instructor



Exchange 106

Kuala Lumpur, Malaysia

Type of structure: **Residential highrise**

Construction work by: **China State Construction Engineering Corporation**

Structure data

- Height: 492 m
- Number of storeys: 106
- Cycle time: 3-day cycle

Products used

- Automatic climbing formwork SKE100 plus and SKE50 plus
- Large-area formwork Top 50
- Protection screen Xclimb 60 with integrated material barrier net

Services

- Formwork planning, Formwork instructor



Aurora Melbourne Central

Melbourne, Australia

Type of structure: **Residential highrise**

Construction work by: **Probuild**

Structure data

- Height: 269 m
- Number of storeys: 92
- Cycle time: 4-day cycle

Products used

- Protection screen Xclimb 60 with monorail system
- Lubeca Jump Form System

Services

- Formwork planning, Pre-assembly, Assembly, Formwork instructor



Varso Tower

Warsaw, Poland

Type of structure: Highrise, office building

Construction work by: Warbud S.A.

Structure data

- Height: 310 m
- Number of storeys: 53 overground, 4 underground

Products used

- Super Climber SCP (self-climbing platform)
- Automatic climbing formwork

SKE100 plus

- Protection screen Xclimb 60
- Panel floor formwork Dokadek 30
- Framed formwork Framax Xlife
- Table lifting system TLS

Services

- Formwork planning, Preassembly of the platforms



Sydney Metro

Sydney, Australia

Type of structure: **Underground subway stations**

Construction work by: **John Holland, CPB Contractors, Ghella Pty Ltd**

Structure data

Differing cross-sections

- Clear width: 4.1 m to 17.2 m
- Clear height: 4.9 to 9.2 m
- Length of each casting section: 5 m to 17.5 m

Products used

- Heavy-duty supporting system SL-1
- Large-area formwork Top 50
- Load-bearing tower d3
- Supporting construction frame
- Dam formwork D22

Services

- Engineering, Formwork instructor, Product Management, Operations, Logistics



E4 Bypass Stockholm

FSE105 Kungens Kurva, FSE502 Hjulsta Norra, FSE61 Akalla, FSE62 Häggvik, FSE215 Skärholmen Stockholm, Sweden

Type of structure: **Tunnel and road construction**

Construction work by: **NCC, Skanska, Züblin Scandinavia AB, Comsa**

Structure data

FSE502 Hjulsta Norra

- Formed length of tunnel: 2 x 370 m
- Length of each casting section: 10 m
- Number of casting sections: 2 x 38 m

Products used

- Heavy-duty supporting system SL-1
- Framed formwork Frami
- Framed formwork Framax Xlife
- Load-bearing tower Staxo
- Large-area formwork Top 50

Services

- Formwork planning, BIM, Field service, Pre-assembly



Lochweidli Tunnel

Wattwil, canton of St. Gallen, Switzerland

Type of structure: **Mining-type and cutand-cover tunnel**

Construction work by: **ARGE Weidli (STRABAG/Heitkamp)**

Structure data

- Formed length of tunnel: 313 m
- Clear width: 10.42 m
- Clear height: 10.65 m
- Length of each casting section: 10 m
- Casting sections: 33

Products used

- Tunnel system DokaMT
- Large-area formwork Top 50

Services

- Planning, Pre-assembly Service, Assembly, Formwork instructor, Dismantling



Tunnel Diel

Nimnica, Slovakia

Type of structure: **Cut-and-cover construction tunnel**

Construction work by: **TUBAU, a.s.**

Structure data

- Clear width: 12.3 m
- Clear height: 8.4 m
- Length of each casting section: 12 m

Products used

- Tunnel system DokaCC
- Large-area formwork Top 50

Services

- Formwork instructor



Galleria Santa Lucia

Calenzano, Italy

Type of structure: **Mining-type tunnel**

Construction work by: **Pavimental Spa**

Structure data

- Formed length of tunnel: 3 tunnels each 60 metres long
- Clear width: 17.6 m
- Clear height: 11.3 m
- Length of each casting section: 6 m

Products used

- Tunnel system SL-1 Volto
- Supporting construction frame Universal F

Services

- Formwork planning



Vamma Power Station

Østfold, Norway

Type of structure: **Hydropower station**

Construction work by: **AF Gruppen Norge AS**

Structure data

- Width: 20 m
- Height: 11 m
- Length: 24 m

Products used

- Large-area formwork Top 50
- Load-bearing tower Staxo 100
- Floor prop Eurex 60

Services

- Pre-assembly Service, Engineering



Keeyask Manitoba

Manitoba, Canada

Type of structure: **Hydropower station**

Construction work by: **BBE Hydro Constructors LP**

Structure data

- Capacity: 695 megawatts
- Formwork used: more than 28,000 m²

Products used

- Dam formwork D22
- Large-area formwork Top 50
- Load-bearing tower Staxo 100
- Framed formwork Framax Xlife

Services

- Formwork planning, Formwork instructor, Pre-assembly



Spittallamm Dam Wall

Lake Grimsel, Grimsel Pass, Switzerland

Type of structure: **Pumped-storage power station**

Construction work by: **ARGE Grimsel**

Structure data

- Height: 114 m
- Length of dam crown: 195 m

Products used

- Dam formwork D22
- Large-area formwork Top 50

Services

- Project management, Pre-assembly, Formwork instructor, Concremote



Cooling tower for coal-fired power plant, Ptolemais Unit 5

Ptolemaida, Greece

Type of structure: **Thermal power plant**

Construction work by: **Hitachi Power Europe, Terna S.A.**

Structure data

- Height: 170 m
- Diameter: 110 m
- Height of each casting section: 1.5 m
- Cycle times: 1-day cycle

Products used

- Large-area formwork Top 50
- Load-bearing tower Staxo 100
- Cooling-tower formwork SK175

Services

- Formwork instructor



Thornton Bank Windpark

Belgium

Type of structure: **Offshore wind farm**

Construction work by: **Skanska Finland**

Structure data

- Height: 44 m
- Conical section: tapering from 17 m to 6.5 m diameter
- Cylindrical section: 9.1 m

Products used

- Climbing formwork MF240
- Large-area formwork Top 50
- Supporting construction frame

Services

- Formwork instructor



Freeport LNG Tanks

Texas, USA

Type of structure: **LNG tank**

Construction work by: **Joint Venture of Technip – Zachry – Saipem**

Structure data

- Height: 37 m
- Height of each casting section: 4.4 m
- Casting sections: 9

Products used

- Climbing formwork MF240
- Large-area formwork Top 50

Services

- Pre-assembly Service



Fire-fighter Training Centre

Náchod, Czech Republic

Type of structure: **Training facility**

Construction work by: **STYLBAU, s.r.o.**

Structure data

- Height: 21 m

Products used

- Load-bearing tower Staxo 100
- Framed formwork Framax Xlife
- Timber-beam floor formwork Dokaflex
- Stair tower 250

Services

- Formwork planning, Pre-assembly, Ready-to-use service, Formwork instructor

Special feature

- Exceptional shaping
- Monolithic climbing wall



Thank you for
your attention



doka