Rak-82-2121 Production Technology of Concrete Structures (2015)

Concrete formwork
28.09.2015

Learning Outcomes

- To acquaint the student with mould techniques

http://endomines.com/images/Second_grinding_milll_pedestal_formwork_completed.jpg

http://src.lafargeholcim-foundation.org/img/3a6981e3-2c05-4dea-ad62-1b9ef3176001/h(true)/c(738-1.333333333333333-100-0-0.00993640699523052)/a11euacch-gallery002x.jpg
Causes of failures

• Inadequate bracing
• Vibration
• Unstable soil
• Inadequate control of concrete placement
• Improper stripping and shore removal
• Concreting practice – control
• Striping of forms – strength of concrete

Materials used for formworks

- Reusable formworks: timber, plywood, steel, aluminium, and composites.
- Stay in place formworks: concrete, steel, steel mesh, plastic, EPS, PU; paper, metal, and plastic pipes
- Uncovered and un-oiled timber can cause uptake of high quantities of water
Types of formwork

Manufactured in situ wooden formwork

- Sawn timber and/or plywood
- Connections by means of nails and screws
- Low degree of re-usability
- Scaffolding; Crane
- Lifting, transportation, and warming equipment
- Thermal insulation
- Wind protection
- Cleaning equipment
Small element systems

- Steel or aluminium frames, metal or plywood panels
- Fast connection
- System solution and flexibility
- Modular dimensions 60x120cm
- Weight 20-25kg or less
- Connections by means of nails and screws
- Low degree of re-usability
Copulas

- Made of fiberglass reinforced resins, plastics or metal
- Steel form can stand 100-150 castings while fiberglass forms can withstand only 30 to 50 times
- Dimensions 1200x1200, 900x1200, 600x1200
- Standard mould weight 20 to 30 kg

http://ad009cdnb.archdaily.net/wp-content/uploads/2013/08/52128a37e8e44e203000021a_ad-classics-niter-i-contemporary-art-museum-oscar-niemeyer_cimg7869-528x351.jpg
Ribbed panels

- 12M modulus is used.
  Length 2000 to 3000mm
- Width 200 to 700mm
- Weight 40-50kg

Supporting structures

- Beams and steel support
- Braces
- Stands
Formworks for columns

- Re-usable

http://i00.i.aliimg.com/photo/v1/887170488_1/plastic_circular_column_formwork.jpg
“Suspended” formwork

- The system forms for instance 200 cm long and 50 cm high with all the supporting elements.
- Additional small panels having height which equals the height of the main panels are connect to the main formwork and are tightened together with special elements.
Large elements system


http://www.worldhighways.com/EasySiteWeb/getresource.axd?AssetID=38866&type=custom&servicetype=Inline&customSizeId=14
Collapsible portable formwork

- Height normally 265 cm, industrial buildings no less than 15 m long
- Length 4 to 8 meters
- Steel, plastic or fiberglass reinforced resin
- Traditionally 6mm plywood sheet
- Support with standard elements
- The moulds halves are interconnected

http://mempex.by/uploads/4_equipment/or15/or15_step_6.jpg
**Table formwork**

- For casting slabs
- The width of the mould is the same like the span of a slab 2.5 to 6m.
- Casting normally between 5 to 7 meters
- Normally thermal insulation of 50mm of mineral wool or cellular plastic (75mm)
- New-cast slab upper surface thermally insulated
- Electric warming of the table moulds

http://www.peri.com/.../image/xl/dam/9f356a0a-3a32-4442-82fc-6326003db87b/multiflex-girder-slab-formwork.jpg
Angular formwork

• Made completely from steel
• Walls and slabs casting at the same time
• Timesaving
• Better distribution of work
• Heating by infrared radiator
• Especially suitable for apartments, hotels and office buildings
• Relatively simple for different dimensions

http://chinaoyu.en.ecplaza.net/6.jpg
Formwork for tunnels

- Completely made of steel
- Less operation in comparison to angular formworks
- Heating and other issues like for angular formwork

Slip formwork

- High buildings, chimneys, staircase towers, pentagonal silos highways and any other linear structures (horizontal or vertical).
- High construction speed, economy, and no joints; economically justified for large structures.
Climbing formworks

- “Self-climb” using special mechanically or hydraulically powered lifting system.
- Regular “fixed” mould
- After concrete has reached demoulding strength the mould halves are released and the entire frame holding formworks as well as working platforms is moved upwards to the next position.

https://upload.wikimedia.org/wikipedia/commons/b/bd/Kletterschalung_Detail.jpg
Special formwork

- Metal decks, prefabricated slabs
- Stay-In-Place Formwork systems (insulating concrete formwork)

Some aspects of formwork design

- Collection of initial data about the building site and structure
- Preliminary choice of formwork type
- Determination of formwork costs
- Choice of additional equipment
- Design – determination of loads, calculation…

<table>
<thead>
<tr>
<th>Horizontal moulds</th>
<th>Wh/m²</th>
<th>Preparation measurements</th>
<th>Montage Stripping</th>
<th>Cleaning Oiling</th>
<th>Together</th>
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<th>Wh/m²</th>
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Loads and pressures

- Formwork itself, Live loads, Movement of equipment, Reinforcement weight, Fresh concrete weight, Additional loads e.g. forces originating from dumping of concrete, External factors e.g. action of wind
- Unsymmetrical placement of concrete, Impact of concrete, Uplift
- Shoring loads multi-storey buildings

http://concreteconstruction.net/Images/Reshoring%20of%20Multistory%20Concrete%20Buildings_tcm45-340417.pdf
Lateral pressure of concrete

- Finland: \( p = W \times h \), Where:
  - \( W \) – density of concrete;
  - \( h \) – depth of fluid (concrete)
- Other countries take into account also such factors like: concrete consistency, temperature of concrete, etc.
Stripping of formwork

- Horizontal members should have at least 70% of the design ultimate strength.
- Vertical elements usually can be de-moulded after 12 (columns) hours or 14 days in the case of large span beam.
- The strength can be checked using non-destructive methods e.g. pulse velocity, rebound hammer.

http://www.swirnowstructures.com/images/Install6.JPG
The most common faults

- Inaccurate sizing: too fast casting
- Not sufficient compaction
- The moulds are unsound or dirty,
- Forms do not have right required dimension tolerances.
- Too much release oil causes concrete surface to be is oily and splotchy
- Lack of release oil causes fast deterioration of formwork surfaces
- Too dry timber causes adhesion to the concrete surface

Formwork and its effect on concrete surface

- Faulty supporting structure and/or formwork surface can cause waviness, curvature, steps. Inappropriate usage of timber for mould surface can cause dehydration, wetting corner areas.
- Porosity: vertical surfaces are less prone to contain air voids in comparison with horizontal surfaces; Air voids may be related with the degree of compaction.
Learning Summary

• Causes of failures
• Materials used for formworks
• Types of formwork