FORMWORK DESIGN DASHBOARD

(Ver 1.0)

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QHSSE Department

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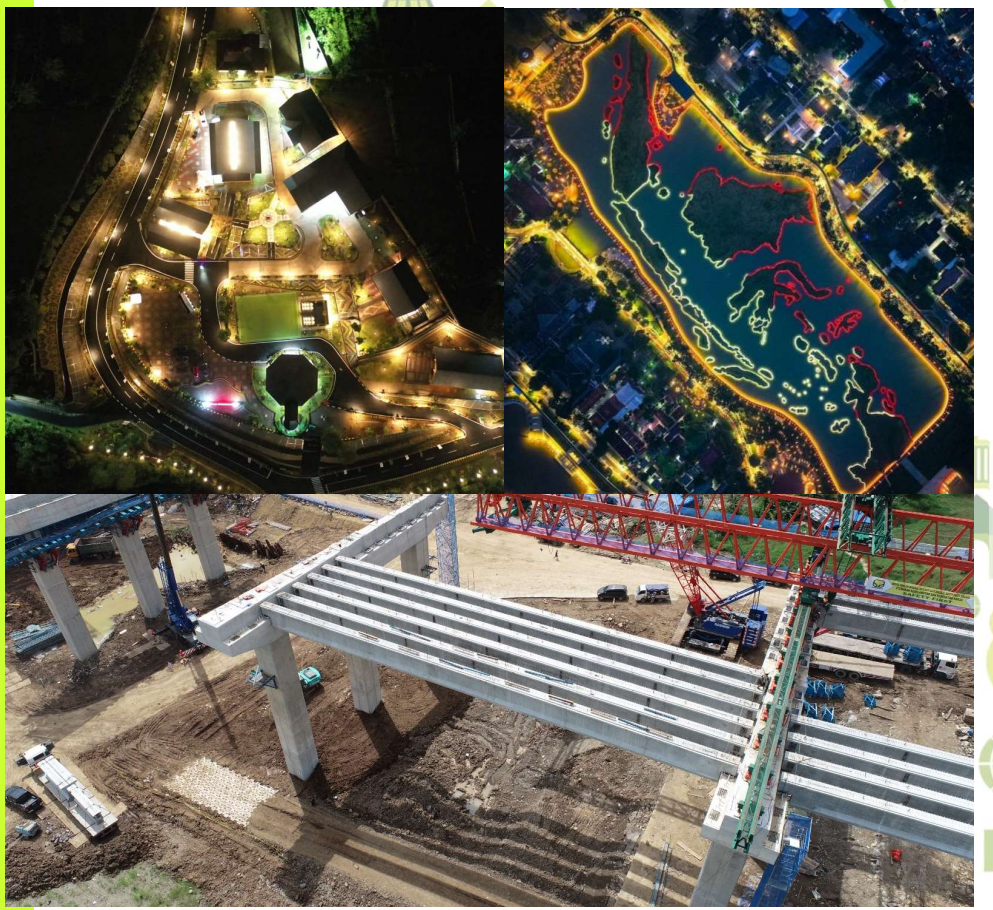

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General Knowledge

Title	"Formwork Design Dashboard (Ver. 1.0)"
Unit	QHSSE Department
Category	Engineering
Innovator	Candra Purna Saputra (13-380) VP Quality and Aesthetic
Contributor	Divisi Operasional 1, Proyek Sungai Bogowonto, Proyek Irigasi Leuweng, Proyek Rusun IKN, Proyek RS. Vertikal UPT Papua

Innovation Background

A pragmatism, and competencies' gap led to a potential of non-conforming product of reinforced concrete deliverable is exposed. Concrete is widely used material in construction industry. In the Process, it requires a formwork to mould the material for fitting the designated shape. The formwork itself, requires a comprehensive planning and design in order to avoid the unexpected condition such as collapse, leak or deflect. It shall be strong enough to accommodate the concrete load and self-weight. The first release of design procedure were not effectively understood and well implemented in the field, thus became the main reason of developing the design procedure into a dashboard interface.

Vision and Purpose

Faster, better, cheaper and safer are the main vision for developing the application of Formwork Design Dashboard. Providing a fast tool for engineer to design and control the concrete formwork. Repackage the expertise requirement into embedded worksheet calculation to reduce the potential of error whilst produce reliable output in safety manner. The main purpose of the application is assisting the engineer in the construction field for better understanding how the moulding work. It can be developed for further case such as quality control tools, cost control tools, procurement and review design protocol.

Formwork Design Procedure Ver. 0.0

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FORMWORK DESIGN

Slab Formwork

Requires Civil engineering fundamental to conclude the calculation result

Step-1

1 Design Load

a	Berat Isi Beton Bertulang	:	2500	kg/m3
	Tebal Plat Lantai	:	0.12	m
	Lebar Model	:	1	m
	Panjang Model	:	1	m
	Percepatan Gravitasi	:	9.8	m/s2
	Berat Beton Bertulang	:	2940	N
	Beban Beton Bertulang Per m2	:	2940	N/m2
	Beban Beton Bertulang Per m2	:	2.94	kPa
b	Beban Sendiri Formwork	:	0.24	kPa
c	Beban Orang	:	2.4	kPa
d	Total Design Load (a + b + c)	:	5.58	kPa

Although the staging process are clearly described, it takes time to remodeling if the first design are failed

Step-2

1 Deck Design

a	Total Design Load (w)	:	5.58	kPa
		:	5.58	kN/m2
b	Jumlah Span Direncanakan	:	lebih dari 3	
c	Material yang akan digunakan (Plywood Kelas 1)			
	1 Tebal	:	12.7	mm
	2 FbKS (Across Support)	:	191000	kPa
	3 FbKS (to ParallelSupport)	:	93000	kPa
	4 Fslb/Q (Across Support)	:	5410	kPa
	5 Fslb/Q (to Parallell Support)	:	2880	kPa
	6 EI (Across Support)	:	1,087,000,000,000	kPa
	7 EI (to Parallell Support)	:	339,000,000,000	kPa

Cek Terhadap Bending

Across Support : 584.64 mm

: 500.00 mm

$$\ell = 3.16\left(\frac{F_b KS}{w}\right)^{1/2}$$

Parallel to Support : 407.95 mm

: 400.00 mm

$$\ell = 3.16\left(\frac{F_b KS}{w}\right)^{1/2}$$

CekTerhadap Geser

Across Support : 1,661.54 mm

: 1600.00 mm

$$\ell = 1.67\frac{F_s Ib/Q}{w} + 2d$$

Parallel to Support : 904.35 mm

: 900.00 mm

$$\ell = 1.67\frac{F_s Ib/Q}{w} + 2d$$

Cek Terhadap Lendutan

Across Support : 427.81 mm

: 400.00 mm

$$\ell = \frac{73.8}{1000}\left(\frac{EI}{w}\right)^{1/3}$$

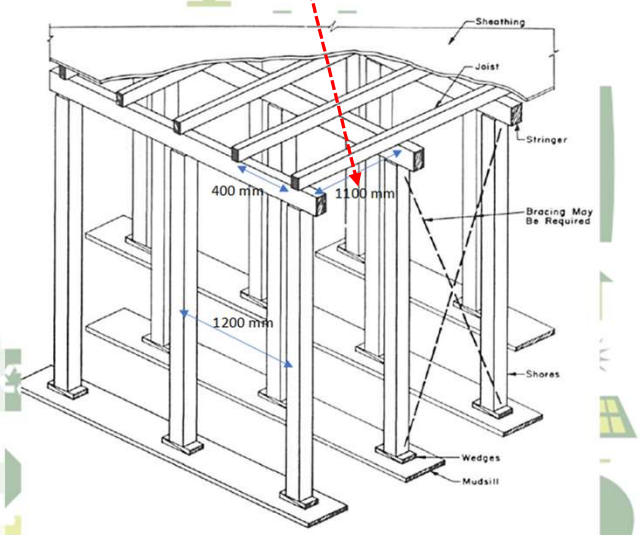
Parallel to Support : 290.12 mm

: 200.00 mm

$$\ell = \frac{73.8}{1000}\left(\frac{EI}{w}\right)^{1/3}$$

Maximum Sheating Support Span : **400.00 mm**

Requires Adjustment for Field Application



Formwork Design Dashboard Ver. 1.0

About Innovation

Innovation Description

Formwork Design Dashboard Ver. 1.0 is a development of conventional formwork design procedure. A conventional design procedure takes time to be proceed and requires more resources (time, cost, expertise) which becomes it's limitation. The output of the conventional design procedure shall be elaborated to suit the labour experience and knowledge to civil engineering fundamental. Abundant limitations of the conventional formwork design procedure has motivated to generate a solution to achieve faster, better, cheaper and safer output whilst easily applicated and straightforward for controlling.

Method of Innovation

Formwork Design Dashboard Ver. 1.0 uses a predictive approach to suit the field implementation of a concrete formwork. The prediction covers the set up process of a concrete formwork to material availability. A source of material database is used to accommodate method adjustment for achieving optimum output of cost and quality. Method of Innovation are described, but not limited to the description below;

1. Straight forward of end user interface.
2. Simple visual basic logical programming for predictive approach.
3. Accommodate the first release version of designing procedure as design attachment report.
4. Adjustable database for agile designing.
5. By passing the Civil Engineering Fundamental whilst the output still reliable and safer by embedding the maximum allowable limit of component placement.

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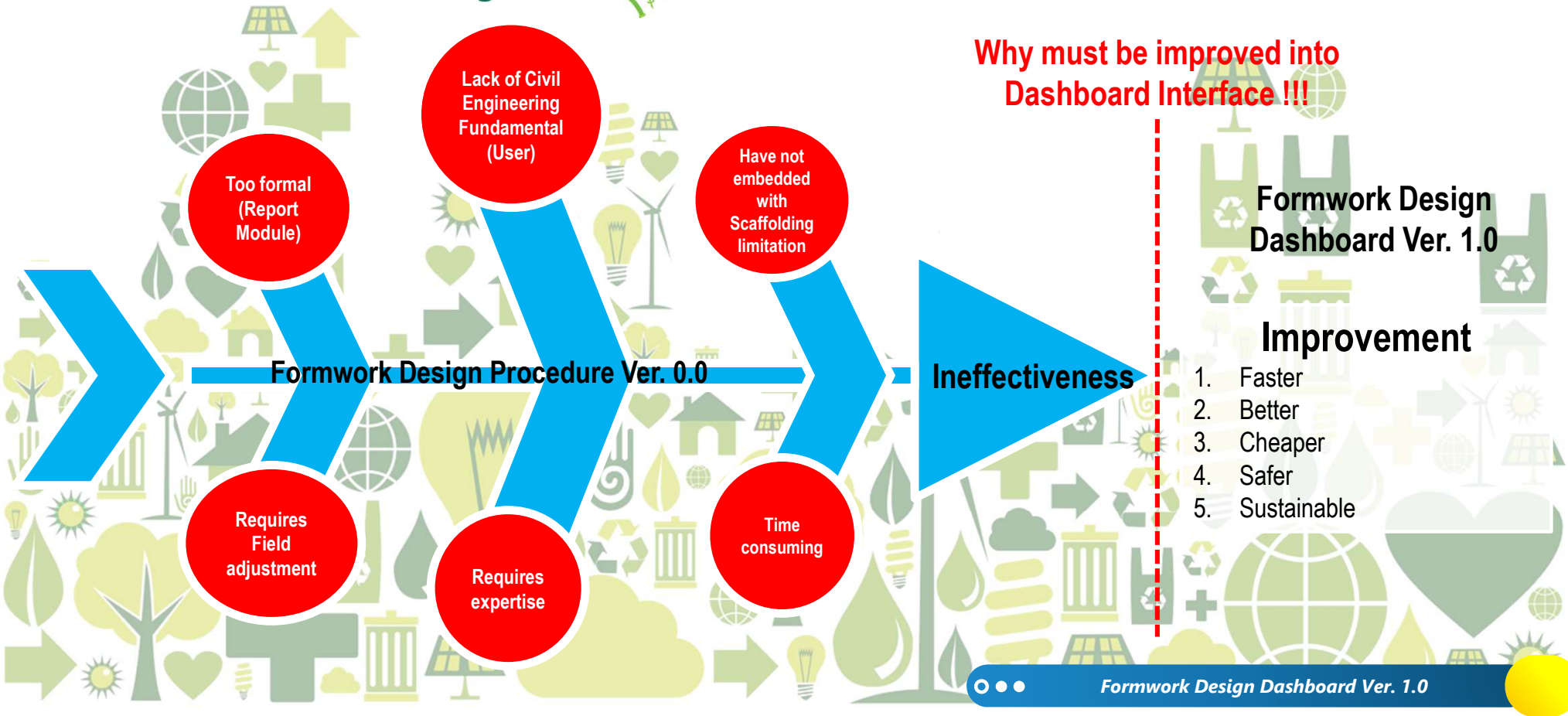
Root Cause Analysis



Why must be improved into Dashboard Interface !!!

Formwork Design Dashboard Ver. 1.0

Improvement

1. Faster
2. Better
3. Cheaper
4. Safer
5. Sustainable

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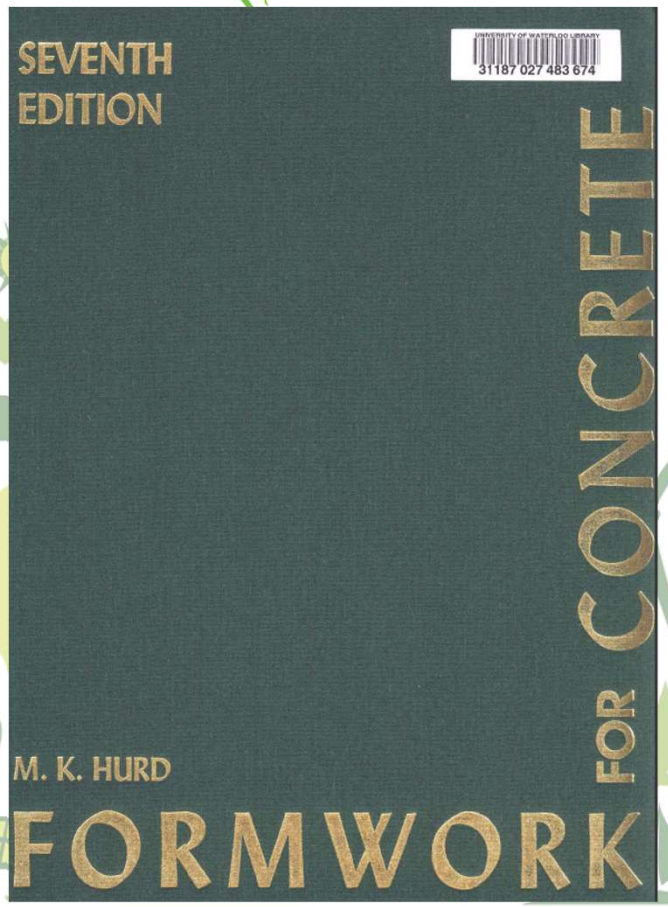
Theoretical Fundamental

Formwork for CONCRETE STRUCTURES

Fourth Edition

Robert L. Peurifoy

Garold D. Oberlender



UNSW SYDNEY | Australia's Global University

Semester 1, 2019

CVEN4102 OPERATIONS AND PROJECTS

Concrete Formwork

Instructor: Dr X Shen

Date: 19 February 2019

Theoretical Fundamental

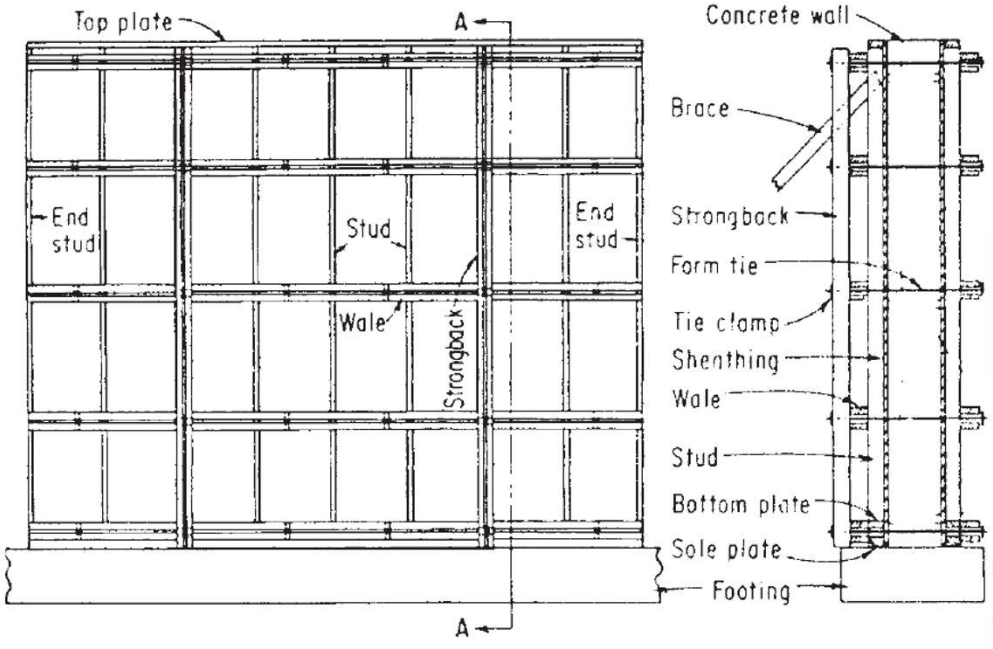
$l/270 = \frac{1}{8}$ in. *(Source : Peurifoy, R.L. 2011)*

$l = 34$ in.

For spans less than 34 in. the $l/270$ limit is more rigid, and for spans greater than 34 in. the ⅛ in. is more rigid. For long structural members, some designers limit the deflection to ¼ in.

Thus, $l/360$ is a more rigid deflection requirement than $l/270$. The selection of these two limiting deflection criteria depends on the relative importance of appearance and strength. If appearance is not important, the less stringent requirement will allow economy in the construction costs of formwork.

Typical Component of the Formwork



(Source : Peurifoy, R.L. 2011)

FIGURE 9-1 Forms for concrete wall.

Theoretical Fundamental

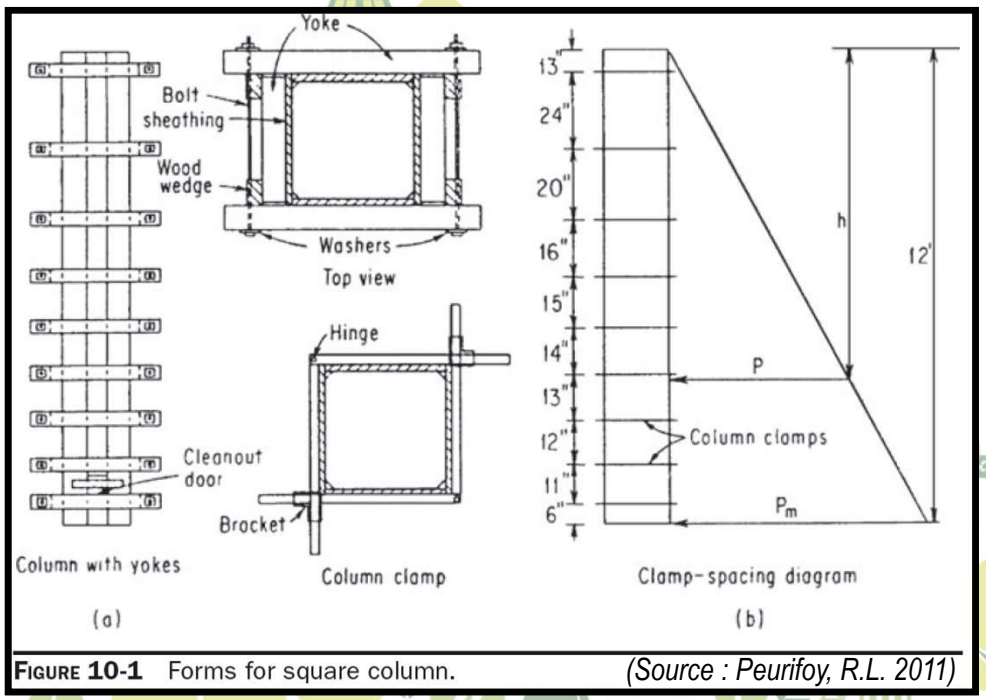
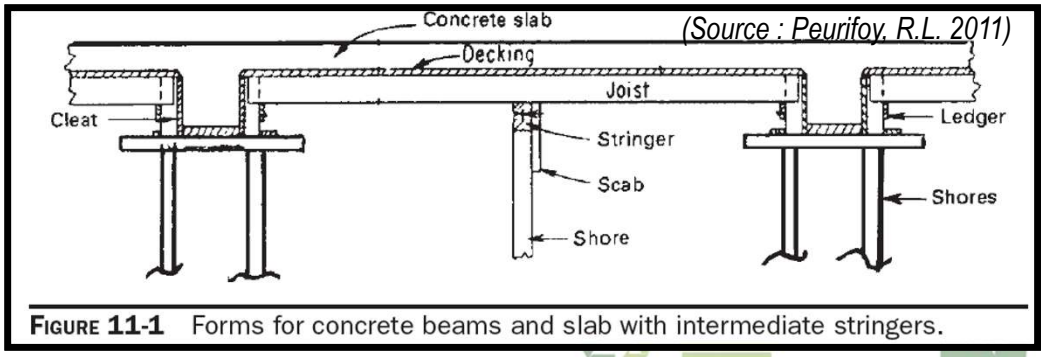


FIGURE 10-1 Forms for square column. *(Source : Peurifoy, R.L. 2011)*



(Source : Peurifoy, R.L. 2011)

FIGURE 11-1 Forms for concrete beams and slab with intermediate stringers.

Typical Component of the Formwork

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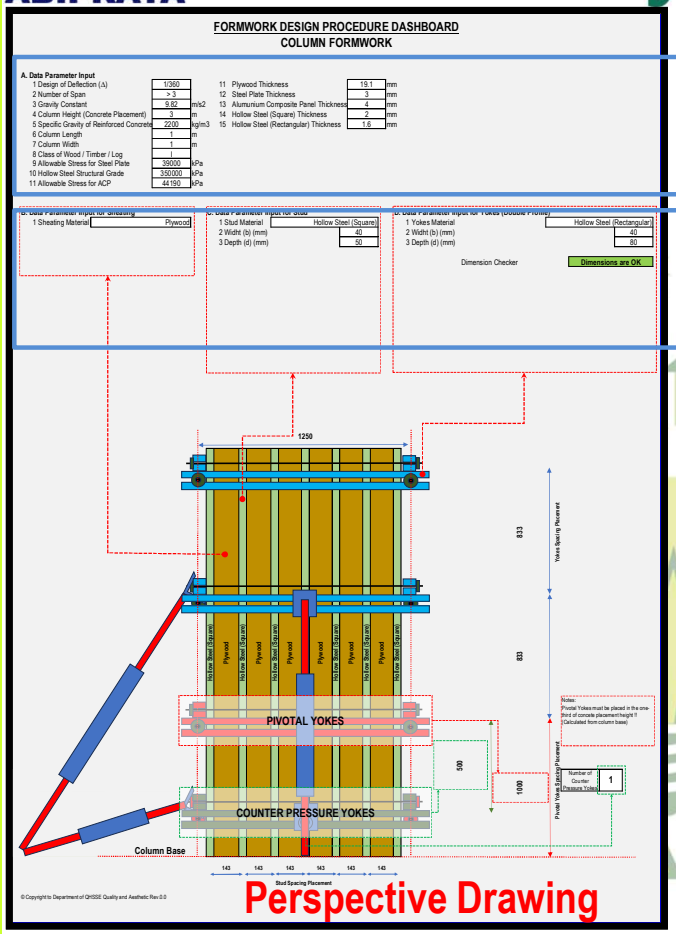
Formwork Design Dashboard Ver. 1.0

Column Formwork



Perspective Drawing

Area of Data Input

Area of Material Selection (Type and Dimension)

What to offer?

1. Accommodating the number of counter pressure yokes are required
2. Allowable maximum span are displayed (Safety concern)
3. Yokes structural calculation embedded with other material selection (Applicability)
4. Fast and reliable output (Faster designing)
5. Material database for further development (Agile)
6. Promoting Sustainability for Paperless Design Output (Sustainability)
7. Less advanced designer expertise accommodation (Cheaper)

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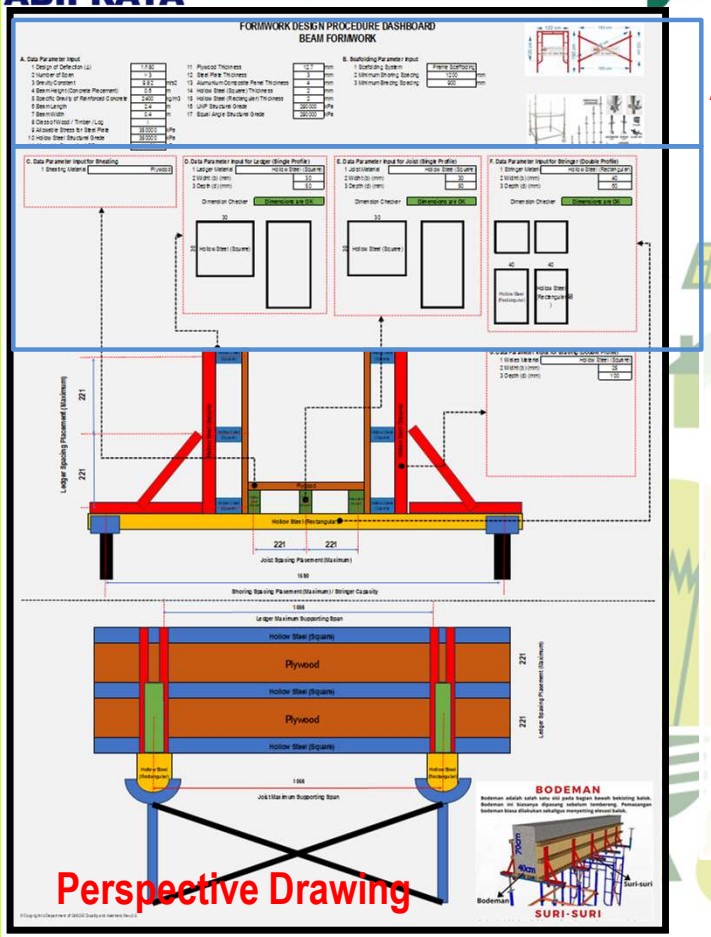
Beam Formwork



Area of Data Input

Area of Material Selection
(Type and Dimension)

Perspective Drawing

What to offer?

1. Accommodating the future plan of scaffolding will be used in the construction site (Adaptability)
2. Allowable maximum span are displayed (Safety concern)
3. Fast and reliable output (Faster designing)
4. Material database for further development (Agile)
5. Promoting Sustainability for Paperless Design Output (Sustainability)
6. Less advanced designer expertise accommodation (Cheaper)
7. It can be developed for calculating scaffolding requirement

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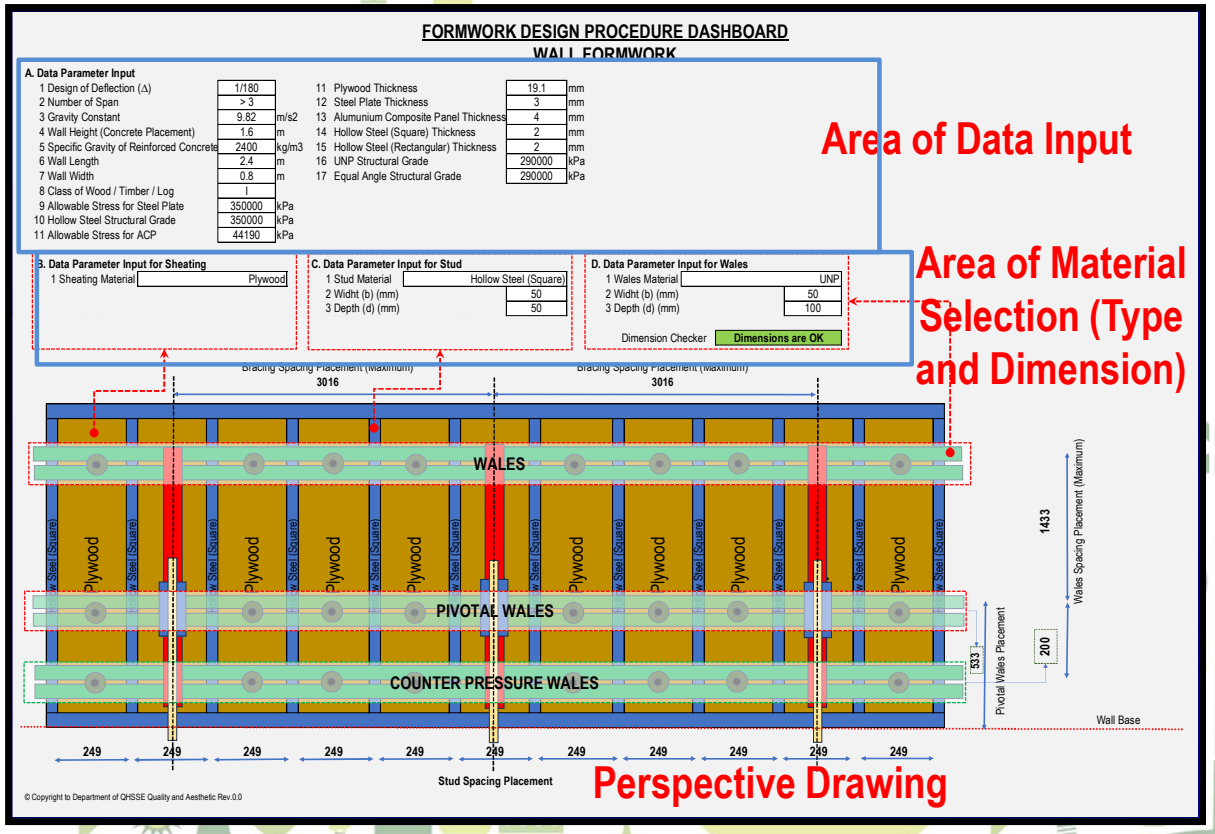
Formwork Design Dashboard Ver. 1.0

Wall Formwork



What to offer?

1. Accommodating the number of counter pressure wales are required
2. Allowable maximum span are displayed (Safety concern)
3. Wales structural calculation embedded with other material selection (Applicability)
4. Fast and reliable output (Faster designing)
5. Material database for further development (Agile)
6. Promoting Sustainability for Paperless Design Output (Sustainability)
7. Less advanced designer expertise accommodation (Cheaper)

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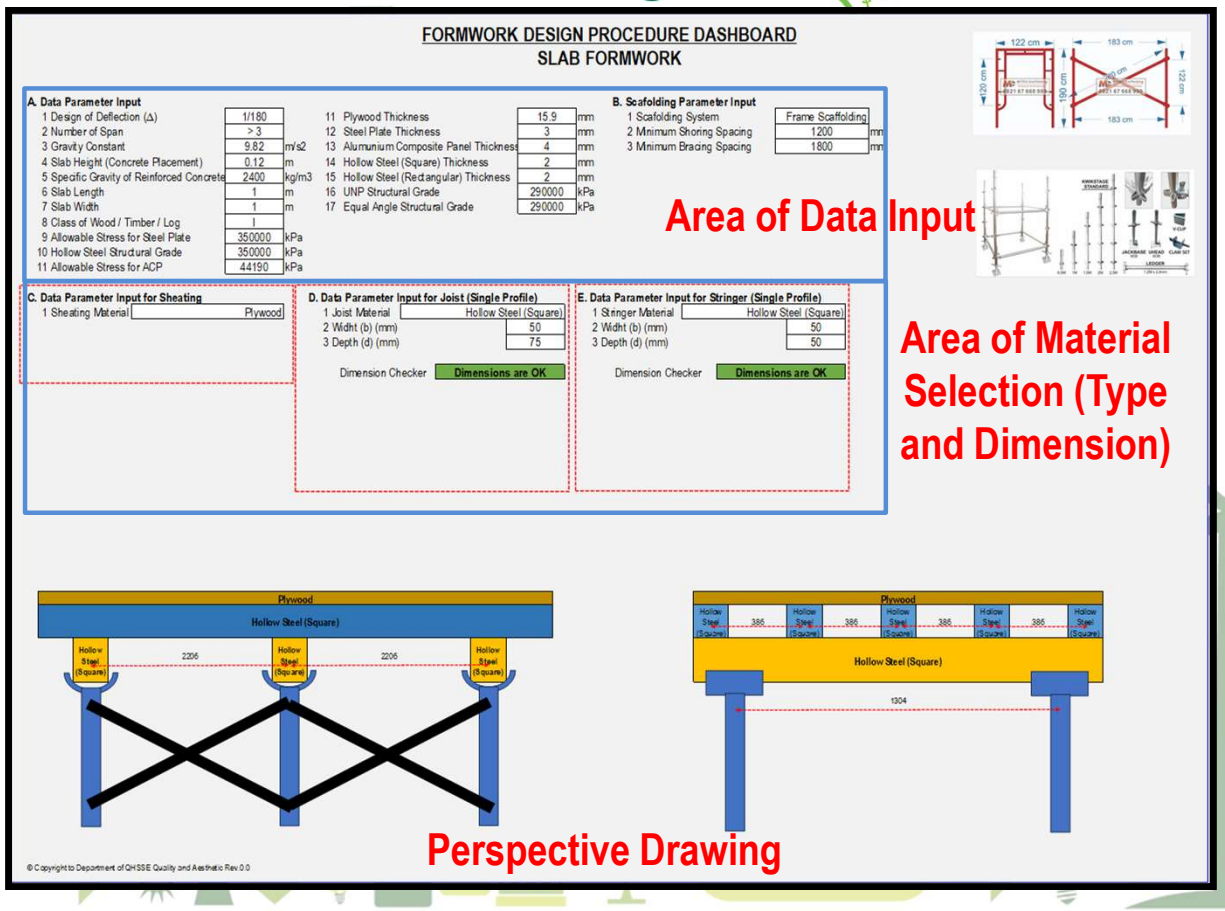
Formwork Design Dashboard Ver. 1.0

Slab Formwork



What to offer?

1. Accommodating the future plan of scaffolding will be used in the construction site (Adaptability)
2. Allowable maximum span are displayed (Safety concern)
3. Fast and reliable output (Faster designing)
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6. Less advanced designer expertise accommodation (Cheaper)
7. It can be developed for calculating scaffolding requirement

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Application and Flow Process

Designing

1

1. Deliverable Drawing (Reinforced Concrete Structure)

Gathering Data

2

1. Input parameter on the Dashboard
2. Review the rule/regulation

Input Data

3

1. Automatic Calculation based on the input dataset

Calculation

Output

4

1. Formwork component placement
2. Embedded Typical drawing for Shop Drawing Fundamental

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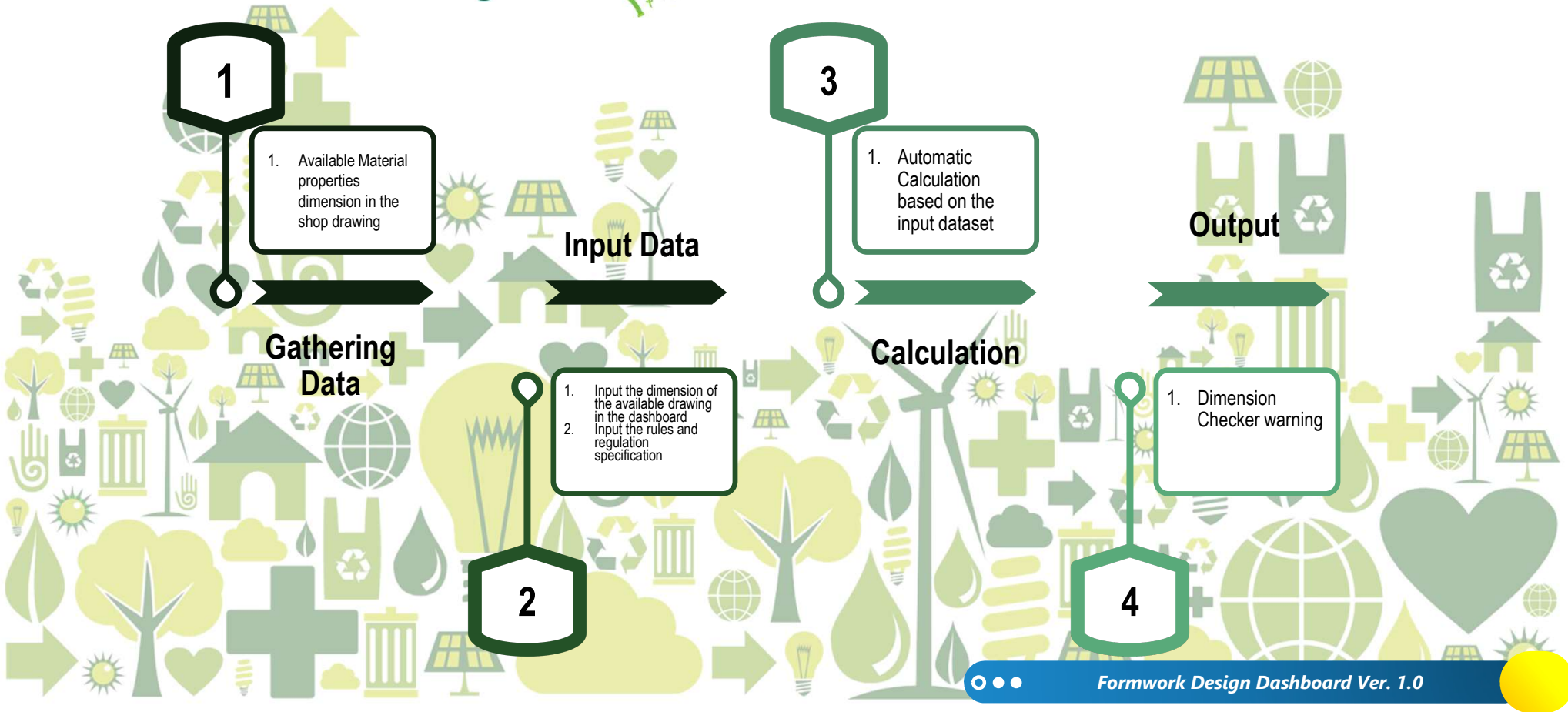
Application and Flow Process

Quality, Safety Control, and Review Design



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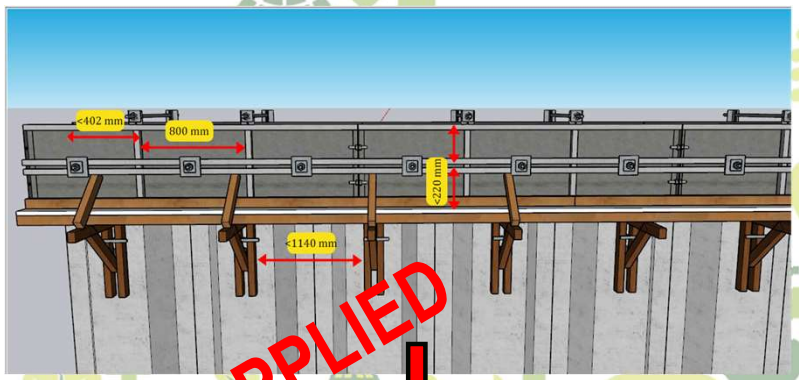
Beta Release Deployment

Proyek D.I. Leuweng

Formwork Design Procedure Ver. 0.0



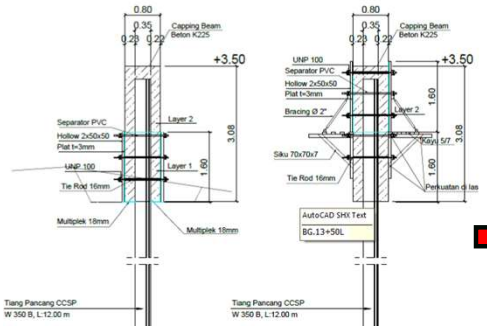
APPLIED

Capping Beam Formwork Initial Design

Capping Beam Formwork Review Design

Proyek Sungai Bogowonto

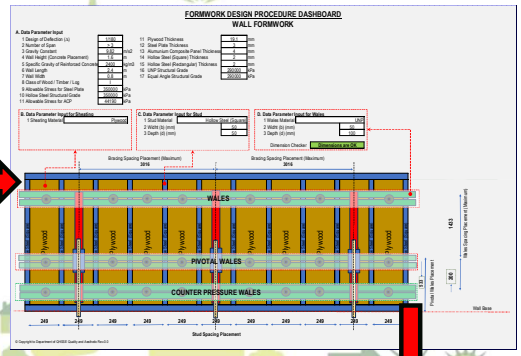
Formwork Design Dashboard (Beta Version)



Concrete Wall Formwork Initial Design

TIPIKAL BEKISTING
Scale 1:100

Formwork Design Dashboard (Wall Formwork) Beta Version

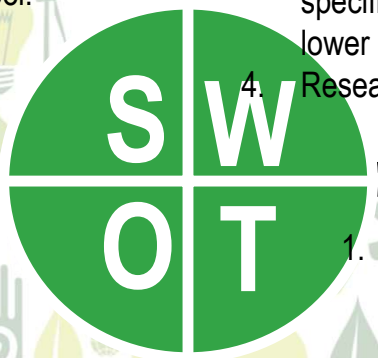


Feedback Inquiry

Feedback Inquiry

Formwork Design Dashboard Ver. 1.0

SWOT Analysis



S

1. Faster, Better, Cheaper and Safer of Design Tools
2. Faster, Better, Cheaper and Safer of Quality Control Tools
3. User Friendly
4. Do not require expertise for designing a concrete formwork.
5. Can be developed into broader perspective in the occasion of cost control, project time control , and procurement tool.

W

1. Limited database on the material selection which are embedded in the Version 1.0
2. Limited assumption of a predictive material in used (Mixing the material e.x Plywood, Aluminium, Steel >> Steel, Steel, Steel)
3. The Dashboard is still based on the Excell Spreadsheet not a specific dashboard application thus the visual appearance is a lower point.
4. Research and Development Fund

O

1. It can be used as powerful tools for supporting project team argument regarding review design proposal
2. It ca be used as a negotiation tools **(after Ver 2.1 Development)**

T

1. The limitation of “Allowable String” in one cell of the Excell Spreadsheet will improve the logical failure. Prone to human error when every calculation stages are manually adjusted.

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Further Development

Procurement (Further Development)

Design Calculation Output

(From Dashboard Calculation)

1. Calculation of Formwork Material requirement
2. Calculation of Scaffolding in used
3. Calculation of Construction sequence

Unit Price per Square Meter of Formwork Deliverable

Formwork Design Dashboard Ver. 1.0

Further Development of Formwork Design Dashboard Ver. 1.0 to Formwork Design Dashboard Ver. 2.1

Units	Total Elapsed Time at Start of Unit, Week	Forms for	Source of Forms
1	0	Columns Beam sides Beam bottoms Slab decking Shores	New material New material New material New material New material
2	1	Columns Beam sides Beam bottoms Slab decking Shores	New material New material New material New material New material
3	2	Columns Beam sides Beam bottoms Slab decking Shores	Unit 1 Unit 1 New material New material New material
4	3	Columns Beam sides Beam bottoms Slab decking Shores	Unit 2 Unit 2 Unit 1 Unit 1 Unit 1
5	4	Columns Beam sides Beam bottoms Slab decking Shores	Unit 3 Unit 3 Unit 2 Unit 2 Unit 2
6	5	Columns Beam sides Beam bottoms Slab decking Shores	Unit 4 Unit 4 Unit 3 Unit 3 Unit 3
7	6	Columns Beam sides Beam bottoms Slab decking Shores	Unit 5 Unit 5 Unit 4 Unit 4 Unit 4
8	7	Columns Beam sides Beam bottoms Slab decking Shores	Unit 6 Unit 6 Unit 5 Unit 5 Unit 5

TABLE 2-2 Schedule of Use and Reuse of Formwork for a Building

Fundamental Guideline

(Source : Peurifoy, R.L. 2011)

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Further Development

Project Control (Further Development)

Design Calculation of Structural Design

- Review Design output of Structural Component (Column, Beam, Slab)
- Design Calculation Output of Framework (From Dashboard Calculation)

1. Calculation of construction sequence

Project Time Schedule

Project cost (Structure Work)

Formwork Design Dashboard Ver. 1.0 + Structural Review Design Report (3rd Party)

Further Development of Formwork Design Dashboard Ver. 1.0 to Formwork Design Dashboard Ver. 2.2

Units	Total Elapsed Time at Start of Unit, Week	Forms for	Source of Forms
1	0	Columns Beam sides Beam bottoms Slab decking Shores	New material New material New material New material New material
2	1	Columns Beam sides Beam bottoms Slab decking Shores	New material New material New material New material New material
3	2	Columns Beam sides Beam bottoms Slab decking Shores	Unit 1 Unit 1 New material New material New material
4	3	Columns Beam sides Beam bottoms Slab decking Shores	Unit 2 Unit 2 Unit 1 Unit 1 Unit 1
5	4	Columns Beam sides Beam bottoms Slab decking Shores	Unit 3 Unit 3 Unit 2 Unit 2 Unit 2
6	5	Columns Beam sides Beam bottoms Slab decking Shores	Unit 4 Unit 4 Unit 3 Unit 3 Unit 3
7	6	Columns Beam sides Beam bottoms Slab decking Shores	Unit 5 Unit 5 Unit 4 Unit 4 Unit 4
8	7	Columns Beam sides Beam bottoms Slab decking Shores	Unit 6 Unit 6 Unit 5 Unit 5 Unit 5

TABLE 2-2 Schedule of Use and Reuse of Formwork for a Building

(Source : Peurifoy, R.L. 2011)

Fundamental Guideline

List of References

Shen, X. 2019, 'Operations and Projects', *Concrete Formwork, University of New South Wales, Sydney, Australia.*

Peurifoy, R.L. 2011, Formwork for concrete structures, 4th Editions edn, McGraw-Hill.

Hurd, M.K. 2005, 'Formwork for concrete', American Concrete Institute.