To All Contractors, Suppliers, Installers, Designers of Formwork Structures and any other interested parties

Circular on Safety Requirements for Formwork Structures

Two workers were killed when a formwork structure collapsed during the concreting of a 23m long by 8m wide and 1m thick slab linking the existing East-West line to the Downtown line at Bugis MRT station. The accident also resulted in eight other workers suffering minor injuries. During the concreting operation, 19 workers were deployed to carry out concreting works on top of the formwork structure while the two deceased workers were deployed below the formwork to watch for leaks and signs of weakness to the formwork structure. The formwork structure collapsed when the concreting was almost completed.

2 MOM would like to remind industry stakeholders on the salient requirements pertaining to the safe design, construction and use of formwork structures as stipulated in the WSH (Construction) Regulations and the WSH (Risk Management) Regulations.

Risk Management

3 Before commencement of work, the responsible person\(^1\) shall conduct a risk assessment in relation to the safety and health risks posed to any person who may be affected by his undertaking in the workplace.\(^2\)

4 The risk assessment should look into the following areas, but not limited to:
   - Formwork structure erection, alteration and dismantling procedures,
   - Base support capacity;
   - Formwork structure stability
   - Placement of rebar;
   - Concrete casting;
   - Working at height;
   - Monitoring of formwork;
   - Formwork leakage;
   - Formwork structural failure;
   - Settlement of formwork structure;
   - Repair of formwork structure;
   - Emergency escape route; and
   - Emergency response plan.

5 All reasonably practicable steps shall be taken to eliminate any foreseeable risk arising from the work to be done. Where it is not possible to eliminate the risk, control measures and safe work procedures shall be implemented to minimise and control the risk.\(^3\)

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1 Responsible person may include employer, self-employed person and principal.
2 WSH (Risk Management) Regulation 3(1)
3
Design of Formwork Structure

6 All formwork structures (including but not limited to beam, slab, wall, column, cantilevered, curved and sloped formwork) shall be capable of withstanding the total dead load, live load and impact load imposed on it with a minimum safety factor of 2.4

| Safety Factor ≥ 2 |

7 A Professional Engineer shall be engaged to design a formwork structure that is:
- supporting a slab or beam to be cast that is greater than 300 mm thick;
- greater than 9 m in height; or
- constructed in 2 or more tiers. (Annex A)

8 The Professional Engineer who designs the formwork structure shall take, so far as is reasonably practicable, such measures to ensure that his design can be executed safely by any person who constructs or uses the formwork structure according to his design.5

9 The Professional Engineer’s design should include the following considerations, but not limited to:
- Vertical and horizontal formwork components;
- Bracing members;
- Connections; and
- Support on which the formwork rest.
The formwork design should encompass all sides, corners and bends supporting the concrete to be cast. Bracing and coupling details should be provided in the design to ensure clarity. (Annex B)

| Formwork design to include bracing and coupling details. |

10 The Professional Engineer who designs the formwork shall also provide to any person constructing the formwork structure all design documentation, including all relevant calculations, drawings and construction (erecting, dismantling and reshoring) procedures to facilitate the proper construction and dismantling of the formwork structure according to his design.6

11 The drawings of the formwork structure should also include the safe means of access7 and escape routes for workers involved with the formwork structure. These should be clearly shown on the drawing plan.

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3 WSH (Risk Management) Regulation 4
4 WSH (Construction) Regulation 58(2), SS 580:2012
5 WSH (Construction) Regulation 64(1a)
6 WSH (Construction) Regulation 64(1b)
7 WSH (Construction) Regulation 58(3b)
Erection of Formwork Structure

12 The Occupier shall ensure that every formwork structure shall
   - be of sound material, good construction and adequate strength;
   - be free from patent defect;
   - be suitable and safe for the purpose for which it is intended; and
   - be properly braced or tied together so as to maintain position and shape.\(^8\)

13 Formwork components used to erect the formwork structure shall be of good condition and free from corrosion. Steel formwork structures should be galvanized for corrosion protection and not painted. (Annex C)

14 As the structural capacity of the formwork structure is expected to be reduced over time, for example due to corrosion, Occupiers may consider, as an additional safety precautionary measure, conduct a load test (in the testing laboratory) to verify the design assumptions of the strength of the formwork structure and their supporting bases, especially for casting of significant structures.

15 Couplers used for bracing and tying the formwork structure together shall be fit-for-purpose, ie. right-angled couplers used for perpendicular members and swivel couplers used for bracing. Using the wrong components could reduce the structural capacity of the formwork structure. (Annex D)

16 Responsible persons shall establish and implement a Fall Prevention Plan to ensure that their workers who are erecting and dismantling formwork structures are prevented from falling from height. Measures may include provisions of safe work platforms with proper guard-rails and personal fall arrest system, complete with safe and secure anchorages.

17 Where it is a requirement for a Professional Engineer to design a formwork structure, the formwork structure shall be constructed in accordance with the design and drawings of the Professional Engineer.\(^9\)

18 No alteration shall be made or allowed to be made to a formwork structure designed by the Professional Engineer unless its design and drawings have been reviewed and endorsed by a Professional Engineer.\(^10\)

19 After erection, the Professional Engineer appointed by the Occupier to oversee the construction of the formwork structure, shall take so far as is reasonably practicable, such measures as are necessary to ensure that the formwork structure
   - is constructed in accordance with the design of the Professional Engineer who designed it; and

\(^8\) WSH (Construction) Regulations 58(1)  
\(^9\) WSH (Construction) Regulations 63  
\(^10\) WSH (Construction) Regulations 63(3)
- is safe for its intended use when completely constructed and if so, issue a certificate stating that the formwork structure is safe for its intended use.\textsuperscript{11}

**Concreting**

20 Every responsible person undertaking any work including erecting/dismantling the formwork structure, installing steel reinforcement or concreting works is reminded to conduct a thorough risk assessment on his work processes and implement the necessary preventive measures to ensure that his undertaking can be and is carried out safely.

21 Formwork structures are to have suitable edge protection to prevent formwork and concreting workers from falling from height. Measures to prevent falling from height as highlighted in the Fall Prevention Plan are to be implemented.

22 Where a formwork structure is designed by a Professional Engineer, placement of concrete shall not commence unless the formwork structure, including any alteration thereto, has been inspected and certified safe for its intended use by a Professional Engineer.\textsuperscript{12}

\begin{center}
**PE to inspect and certify formwork structures.**
\end{center}

23 During concreting, the formwork system should be regularly monitored by the formwork supervisor for movement, stability and soundness. The formwork supervisor and any other workers should not work under or in close vicinity of the formwork structure while the pouring of concrete is in progress. Proper risk assessment shall be conducted to ensure that the formwork supervisor watching the formwork is not exposed to the risk from formwork structure collapse.

\begin{center}
**No one to be under formwork during concreting.**
\end{center}

24 If, during concreting, any weakness develops and the formwork shows any undue settlement or distortion, all work shall be stopped immediately. Prior to the commencement of any adjustment, strengthening or repair works, a thorough assessment of risk shall be conducted and all necessary measures to be taken to ensure that workers will not be exposed to risks from formwork structure collapse.

**Dismantling of Formwork Structure**

25 A formwork structure should only be dismantled after the concrete has sufficiently set and after a period of time as determined by the Qualified Person (Design) or otherwise, with reference from SS 580\textsuperscript{13}.

26 The manner of dismantling a formwork structure should be in accordance to the Professional Engineer’s dismantling procedures, taking into account that the formwork structure could be unstable during dismantling.

\textsuperscript{11} WSH (Construction) Regulations 64(2)

\textsuperscript{12} WSH (Construction) Regulations 65(3)

\textsuperscript{13} SS 580: 2012 Section 8.2, 8.3
Please refer to www.mom.gov.sg for the Workplace Safety and Health Act and its subsidiary regulations. Please contact Mdm. Koh Chin Chin at koh_chin_chin@mom.gov.sg should you have any queries.

For your immediate compliance.

KEVIN TEOH
for COMMISSIONER FOR WORKPLACE SAFETY AND HEALTH
A Professional Engineer shall be engaged to design a formwork structure that is:

(i) Supporting a slab or beam to be cast that is greater than 300mm thick

(ii) Greater than 9m in height

(iii) Constructed in 2 or more tiers
Annex B

Formwork drawing – typical elevation showing details of bracings and couplers

Type of couplers used to be indicated.

Bracing details provided.
Corroded formwork components used

Corroded formwork components painted over to mask the corrosion

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<td>OSHD/OSHI/MI046</td>
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Annex D

Examples of Couplers

Swivel Couplers

Right-Angle Couplers