

Safety at Work

Falsework - Prevention of Collapse

GUIDANCE NOTES

SAFETY AT WORK

(FALSEWORK — PREVENTION OF COLLAPSE)

This Guidance Notes is prepared by the
Occupational Safety and Health Branch
Labour Department

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1. INTRODUCTION

- 1.1 Falsework is a temporary structure used to support a permanent structure while the latter is not self-supporting. Total or partial collapse of a falsework may lead to serious accidents. It may cause loss of life, damage to property and delay in work progress. Instability, defective or sub-standard materials, faulty setting out are the common causes of their collapses.
- 1.2 These Guidance Notes highlight the good practices sometimes overlooked by the contractor to prevent collapse of falsework on construction sites in Hong Kong. It is intended to be read by the site management personnel and competent engineers.
- 1.3 Guidance on design, construction, use and dismantling of falsework can be found in relevant codes of practice, such as British Standard BS 5975 - Code of Practice for Falsework.
- 1.4 The guidelines contained in the Guidance Notes should not be regarded as exhausting those matters which need to be covered by the relevant safety legislation. Compliance with the Guidance Notes does not confer immunity from relevant legal requirements.

2. RESPONSIBILITIES

- 2.1 Legal requirements to ensure safety of a workplace are given in Sections 6A or 6B of the Factories and Industrial Undertakings Ordinance, and the Construction Sites (Safety) Regulations.

- 2.2 Under the Factories and Industrial Undertakings Ordinance, the management personnel who have management or control of the business conducted on the construction site are regarded as the proprietor. They may include managers, site agents, architects, engineers or foremen.
- 2.3 Under the Construction Sites (Safety) Regulations, the principal contractor responsible for a construction site should make and keep every workplace safe on site.

3. DESIGN STAGE

3.1 Competent Engineer

- 3.1.1 The contractor should appoint a competent engineer to design a falsework. To qualify as a competent engineer in designing falsework, he should have adequate training and experience, have competence in structural mechanics and geotechnics, and be able to justify how and why the falsework can safely resist the effects of the loads without undue movements in accordance with recognised engineering principles.

3.2 Drawings and Specifications

- 3.2.1 In designing falsework, the competent engineer should prepare a set of instructions in the form of drawings and specifications specifying the framing, construction details (especially for connections), methods of erection, sequence of erection, standard of materials and workmanship, and method statement for dismantling. Safe access and egress for workmen should also be clearly shown. To enable the competent engineer's intentions to be realised on site, all parties concerned including subcontractors, should have a set of these instructions.

3.3 Engineering Justifications

3.3.1 The framing of structural members and details of construction should be justified in accordance with recognised engineering principles to meet the loads to which the falsework may be subjected. The loads include vertical loads and lateral loads, and the common ones are given below :-

(a) Vertical Loads from

- (i) Self-weights.
- (ii) Permanent works to be supported.
- (iii) Impact due to placing permanent works (e.g. free fall of wet concrete).
- (iv) Construction operations. A minimum of 1.5 KN/m^2 should be allowed for the operations.
- (v) Temporary storage of materials.
- (vi) Traffic loads.
- (vii) Plant. The operating loads should include the weight of plant, dynamic effects and vibration effects.
- (viii) Induced wind loads.
- (ix) Uplift loads due to wind and floatation.

(b) Lateral Loads from

- (i) Wind loads.
- (ii) Hydrostatic pressure. It may come from wet concrete or an external source.
- (iii) Lateral earth pressure.
- (iv) Differential movements of supports such as ground movements.
- (v) Vibration effects such as those due to concrete vibrations or piling operations nearby.
- (vi) Flowing current.

- (vii) Unsymmetrical distribution of vertical loads, such as effects due to unbalanced concrete placing.
- (viii) Unsynchronized jacking of permanent works against falsework.
- (ix) Sway of falsework.
- (x) Buckling of props.
- (xi) Eccentricity of vertical loads due to construction deviations, especially for falsework on sloping ground.
- (xii) Dynamic effects from plant and equipment.

3.3.2 The minimum lateral loads should be taken as the greater of :-

- (a) the most adverse combination of the above lateral loads; or
- (b) 2.5% of the vertical loads taken as acting at the points of contact between the vertical loads and the supporting falsework.

3.3.3 Each falsework member should be designed for the most adverse combination of vertical loads and lateral loads.

3.4 Site Conditions

3.4.1 The competent engineer should realise the site conditions such as ground conditions, topographic features, earth slope characteristics, ground water data and standard of workmanship achievable before incorporating them in the design.

3.5 Structural Steel Works

- 3.5.1 Use structural steel in accordance with the Code of Practice for the Structural Use of Steel issued by the Building Authority or an equivalent international standard.
- 3.5.2 Steel hollow sections exposed to the weather should have walls not less than 4 mm thick, unless protection against corrosion is effectively provided and maintained.
- 3.5.3 Steel members of hollow sections are often used repeatedly. As some damage is expected after each cycle of use, they should be inspected prior to reuse and be discarded if found unsatisfactory.

3.6 Lateral Stability

- 3.6.1 The key to keep falsework safe is the provision of adequate lacing and bracing to prevent the falsework from buckling or sway.
- 3.6.2 Lacing are horizontal members connecting props together to reduce the unsupported length of the props. They may behave as struts or ties, and help to transmit lateral forces to bracing members.
- 3.6.3 Bracing generally are inclined members connecting lacing members and props. For further details, see BS 5975. They transmit lateral forces to the foundations.

- 3.6.4 Lacing and bracing must be recognised as critical members in falsework. They should be adequately provided in compliance with recognised engineering principles. They should be clearly shown in the drawings in the three principal directions to illustrate the competent engineer's intentions. Undue movement due to lateral forces, torsion or impact forces should be prevented. A properly planned loading sequence will alleviate torsional effects.
- 3.6.5 If possible, the falsework should be tied back to stiff parts of completed permanent structures to enhance lateral stability.
- 3.6.6 The framing of falsework should give a robust and stable structure, especially for falsework near vehicular traffic. The structure should be designed and constructed so that it is not unreasonably susceptible to effects of impacts or vibrations. Damage to small areas of a structure should not lead to collapse of major parts of the structure. To avoid accidents, adequate headroom, lighting, warning signs and signals, and impact protection measures should be provided.

3.7 Cantilever Members

- 3.7.1 The end portion of a prop protruding beyond a lacing member should be considered as a cantilever member unless adequate means is used to brace the end portion. Such end portion often occurs at the top or at the base of a prop.

3.7.2 If a prop has an extensible portion at the end, the joint between the extensible portion and the prop itself allows a little angular movement. Such movement constitutes a weak point in the falsework. Unless otherwise justified by recognised engineering principles, the extensible portion should be adequately laced and braced at the end where the extension exceeds 300 mm.

3.8 Fastenings to Concrete or Masonry

3.8.1 All fastenings to concrete or masonry for structural uses should be designed in accordance with recognised engineering principles and the manufacturer's recommendations. The construction details and instructions for use should be clearly specified in the drawings and specifications.

3.9 Foundations

3.9.1 All props of falsework should be adequately supported without risk of undue displacement during the life-time of the falsework. Points of contact between the props and underlying works should comprise baseplates connected to the feet of the props, resting on distribution members if necessary.

3.9.2 If the props are supported by the ground, the ground should be treated to enhance even setting of the distribution members, and to ensure that the allowable bearing capacity of the ground will not be exceeded.

3.9.3 On sloping supports, the props of the falsework should be effectively prevented from sliding. An appropriately shaped wedge should be inserted to the void between each prop's baseplate and the sloping foundation to ensure tightness and verticality.

3.10 Loading Sequence

3.10.1 Sequence of placing loads on the falsework including loads due to temporary storage and prestressing should be planned and taken into account in the design.

3.11 Method Statement for Erection / Dismantling

3.11.1 The methods for erecting and for dismantling the falsework should be included in the drawings in a clear and understandable form. Such a method statement should include :-

- (a) details of the methods in each stage of erection / dismantling;
- (b) sequence of erection / dismantling;
- (c) plant and equipment to be used;
- (d) details of working platforms and access routes;
and
- (e) details of anchorage if any.

3.12 Feed-back from the Site

3.12.1 Feed-back information from the site during progress of work, such as change of site conditions and problems associated with methods of erection, use or dismantling should be reported to the competent engineer or the falsework coordinator if appointed. Amended drawings or specifications if required should be issued to meet the prevailing circumstances.

4. CONSTRUCTION STAGE

4.1 Competent Construction Supervisor

4.1.1 The contractor should appoint a competent construction supervisor to supervise the construction of falsework. The supervisor should have sufficient technical knowledge and management skills, and be able to read and understand the drawings and specifications for the falsework.

4.2 Drawings and Specifications

4.2.1 To realise the competent engineer's intentions, the contractor including the site management personnel should read and understand the drawings and specifications for the falsework before commencing erection. If the contractor has doubts as to any detail or sequence of construction, he should seek clarification from the competent engineer. Adequate connections particularly between members of different materials (such as those between steel members and timber members) should not be overlooked. Poor connections often lead to collapses.

4.3 Competent Supervision

4.3.1 Site management personnel and workman in falsework construction should be competent in the work assigned. They should also be trained to fully understand the contents of the drawings and specifications for the falsework, especially the sequence of erection which should strictly be adhered to.

- 4.3.2 The contractor should give continuous and adequate supervision on the falsework. He should also check the as-constructed falsework against the drawings and specifications, and assure himself that the falsework is fit for the intended use.
- 4.3.3 The supervision should include rejecting the materials and workmanship of the falsework which contains missing members, unsatisfactory connections, inadequate wedging, misalignment of members, displacement of adjustable forkheads or baseplates, deterioration of members or other sub-standard works, and using of suitable personal protective equipment.
- 4.3.4 The contractor should also ensure that the workmen at work use suitable personal protective equipment.

4.4 Prevailing Site Conditions

- 4.4.1 Site conditions change from time to time. Deviations from the competent engineer's intentions discovered on site should be resolved with the competent engineer. The contractor should not change the design without the competent engineer's agreement.

4.5 Coordination between Contractor and Competent Engineer

- 4.5.1 The contractor faces site problems everyday which are often not anticipated by the competent engineer. The contractor should coordinate with the competent engineer on construction details, sequence of working and site problems, and agree on amendments of the design to suit the site constraints. Any amendment of the design should be certified by the competent engineer. Let the competent engineer share the contractor's concern over the site problems and let him help the contractor to solve the problems.

4.6 Complying with Good Practices

4.6.1 The contractor should erect the falsework in accordance with the drawings and specifications. If any method of working or construction detail is not expressed in the drawings and specifications, the contractor should follow the good practices recommended by relevant codes of practices, such as BS 5975. Sub-standard materials or workmanship, especially those for connections often trigger collapses. Connections between members of different materials should be treated with great care. Such details should be given in the drawings and specifications.

4.7 Lacing, Bracing & Wedging

4.7.1 Falsework will not be safe without adequate lacing, bracing and wedging. The contractor should not permit workmen to install lacing, bracing or wedging in favour of their own decisions. Follow all the details shown in the drawings and specifications.

5. USING STAGE

5.1 Drawings and Specifications

5.1.1 The contractor should check that the as-constructed falsework has been properly erected in compliance with the drawings and specifications before allowing workmen to put loads on the falsework.

5.2 Competent Supervision

- 5.2.1 All works, especially interface works between different trades should be continuously supervised by competent site management personnel. The contractor should also continuously monitor the falsework throughout his use to ensure that the falsework is maintained in the relevant conditions, and should ensure that all the necessary safeguards are maintained and used. Records of the monitoring should be kept.

5.3 Loading Sequence

- 5.3.1 The sequence of placing permanent works such as wet concrete should comply with the competent engineer's intentions expressed in the drawings and specifications. If such a sequence has not been specified, the contractor should ask for the loading sequence from the competent engineer. If the competent engineer still does not require a specific loading sequence, then the contractor should plan the sequence of working by spreading the loads evenly on the falsework. Uneven distribution of loads, such as out-of-balance effects due to unsynchronized jacking of permanent works against the falsework by more than one jack may lead to uplifting or instability.

5.4 Loading Pattern

- 5.4.1 Concrete pouring by crane, skip, barrow, dumper or pumping produces impact forces. The free fall should not exceed 0.5 m unless otherwise permitted by the competent engineer. Heaping of wet concrete within a small area should be avoided, e.g. in an area of one square metre the height of the heap above the formwork surface should not exceed three times the depth of the slab unless otherwise shown in the drawings. Unless otherwise permitted by the competent engineer, equipment for concrete pumping should not be fastened to the falsework.

5.5 Undue Movement of Falsework

- 5.5.1 The works under construction should be suspended when any undue movement of the falsework occurs. Investigation on the causes of the undue movement should be carried out by the competent site management personnel with the help of the drawings and specifications. If any doubt still exists, the competent site management personnel should immediately seek the competent engineer's advice. Safety can only be assured if the site management possesses the competence to make timely decisions to prevent a collapse.

6. DISMANTLING STAGE

6.1 Competent Dismantling Supervisor

6.1.1 The contractor should appoint a competent dismantling supervisor to supervise the dismantling work. The supervisor should have sufficient technical knowledge and management skills, and be able to read and understand the method statement for dismantling the falsework.

6.2 Drawings and Method Statement

6.2.1 The supervisor should have a set of drawings showing the method statement for dismantling the falsework. The method of safe removal, lowering and transportation of dismantled materials by suitable means, including safe working platforms and safe access should be specified.

6.3 Competent Supervision

6.3.1 The contractor should ensure that every workman engaged in the dismantling operation has the required competence to undertake the work assigned. The workman should be trained to fully understand the contents of the method statement, especially the sequence of dismantling which should strictly be adhered to.

6.3.2 The contractor should provide continuous supervision on all dismantling operations.

6.3.3 The contractor should also ensure that the workmen at work use suitable personal protective equipment.

6.4 Dismantling Operation

6.4.1 In dismantling falsework, the followings should be observed :

- (1) No part of the falsework should be disturbed until the permanent works have attained the self-supporting strength and stability.
- (2) Bracing members should be removed as late as practicable unless otherwise specified in the method statement.
- (3) Dismantling falsework by deliberate collapse involving removal of key structural members causing complete collapse of a space frame should not be allowed.

Useful Information

If you wish to enquire about this guidance notes or require advice on occupational safety and health, you can contact the Occupational Safety and Health Branch of the Labour Department through :

Telephone : 2559 2297 (auto-recording after office hours)

Fax : 2915 1410

E-mail : enquiry@labour.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page on the Internet. Address of our Home Page is <http://www.labour.gov.hk> .

Information on the services offered by the Occupational Safety and Health Council can be obtained through hotline 2739 9000.