Temporary Steel Platforms

A guide to good practice

Publication

Published by HK Temporary Works Forum (HK-TWf)

2018

Contents

Appendices

Foreword

Temporary steel platforms (TSPs) are common to construction sites that require plant movement and/or storage on slopes, offshore construction or deep excavations with space constraints. At present, there is a lack of local codes of practice or design guidelines specifically addressing TSPs and, as a consequence, platforms of varying degrees of robustness are being used that on occasions have resulted in serious accidents.

This Temporary Works Forum (TWf) Guide is intended for industry practitioners, particularly for temporary works designers and site responsible persons, who are accountable for the engineering and/or installation, use and removal of TSPs. It outlines examples of good practice in design, communication of design intent and risk, buildability considerations and technology applications. A checklist has been prepared by the authors as a reference for TSP designers.

Acknowledgement

The Hong Kong Temporary Works Forum (HK-TWf) gratefully acknowledges the contribution made by members of the working group in the preparation of this guidance:

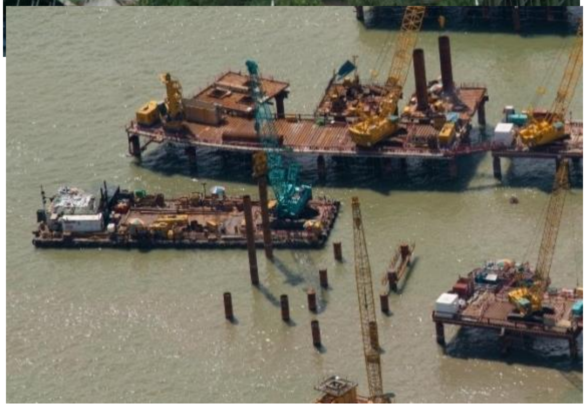
Askew, Ian	Gammon Construction Limited
Chan, Paxon	Arcadis Design and Consultancy
Dundar, Serdar	Benaim (an Aecom Company)
Hopkin, William	Leighton Contractors (Asia) Ltd.
Lam, Terence	Personal Capacity
Southward, Nick	Tony Gee and Partners (Asia) Ltd.
Szeto, Tommy	Aurecon
Toh, Gavin	Lambeth Associates Limited
Gutierrez, Edwin	Lambeth Associates Limited

References

1. UK TWf (Draft) "*Working Platforms – Design of granular working platforms for construction plant – A guide to good practice*"
2. Buildings Department, "*Code of Practice for Site Supervision 2009*"

1. GENERAL MATTERS

1.1 Scope

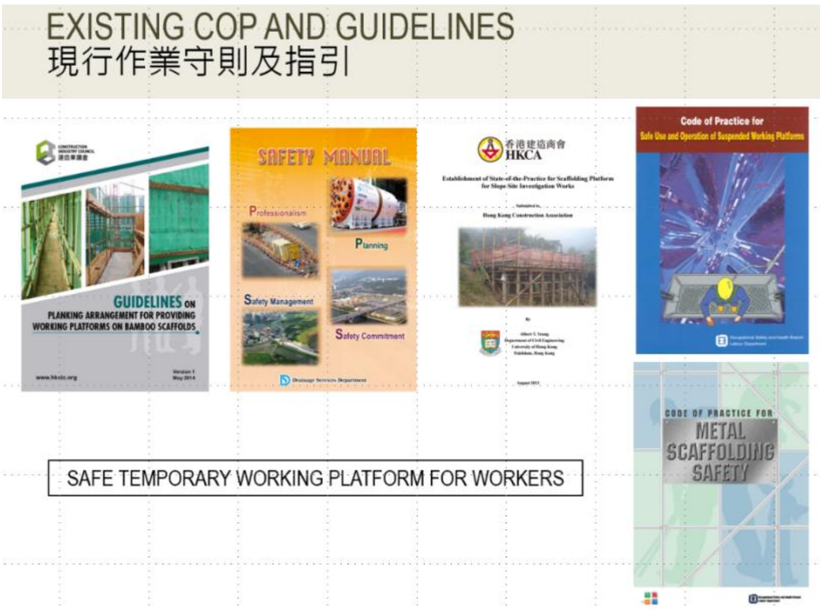


Recommendations and good practice described in this guide are generally applicable to steel platforms for:

- general access and lifting operations;
- material storage;
- piling operations;
- traffic decks; and
- marine construction.

Timber, bamboo or metal scaffolding, platforms for supporting permanent works or platforms formed from a mixture of materials are not covered.

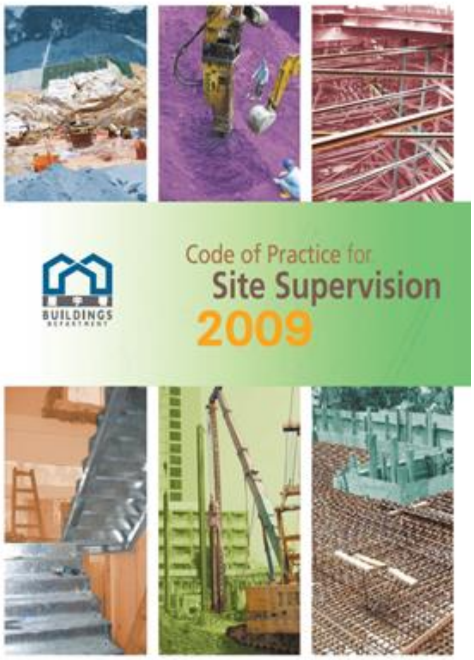
1.2 Legislation



The design of TSPs is subject to the same general local legislation that governs all construction works. This is amply covered elsewhere in the publications of the Buildings Department, Labour Department, the Occupational Safety and Health Council and the Construction Industry Council.

For the purposes of this guide, this section draws attention to the relevant sections of the Code of Practice for Site Supervision 2009 (the 'Code') of the Buildings Department. One of the objectives of the Code is to set out and explain the division of responsibility for safety management in construction works that include temporary works (Para. 3.1(c)). Temporary work has been broadly classified into three cases (Para. 4.7):

- Case 1 – where the temporary work and the sequence of construction/method statement is shown on prescribed plans, the Authorised Person (AP)/ Registered Structural Engineer (RSE)/ Registered Geotechnical Engineer (RGE) and Registered Contractor (RC) are responsible for supervising execution of the temporary work.
- Case 2 – where the temporary work is not shown on prescribed plans and has no effect on the permanent structure by way of overstressing/overloading, the RC has sole responsibility.
- Case 3 – where the temporary work is not shown on prescribed plans but may have an effect on the permanent structure by way of overstressing/overloading, the RC shall appoint a person to certify the design and the completed temporary work.



More details of the division of responsibilities and duties of AP/RSE/RGE and RC and their representatives are given in Section 4 of the Code.

Temporary platforms are required to be shown on prescribed plans under Buildings Department approval if they fall within the two scenarios given below:

i. If a temporary platform is required for heavy piling machines for the piling works; and
ii. "Significant geotechnical content" is involved as a result of the construction of the temporary platform, for instance, when a platform is on or adjacent to steep slopes/retaining walls/scheduled areas/tunnels/caverns.

1.3 Reliability and Economy

The following paragraphs, extracted from the UK TWf's guide on granular platforms (Ref. 1), are relevant to the TSP covered in this guide.

> *In all cases, the aim of any design is to achieve a sufficiently reliable design balanced with the need for economy. A reasonable compromise needs to be struck to achieve a sufficiently safe design while avoiding excessive over design.*
>
> *The level of reliability required for any structure is based on the perceived risk of collapse and the associated likely consequences. The level of reliability achieved for a structure is a product of the accuracy of input data, design method and the construction process.*


TWf2016: 01_DRAFT
Page 1 of 134

TW15.120

WORKING PLATFORMS

Design of granular working platforms for construction plant
A guide to good practice

Publication

Published by Temporary Works Forum c/o Institution of Civil Engineers, 1 Great George Street, London, SW1P 3AA, England

First Published TBC

available as a free download from www.twforum.org.uk

Most TSP failings that have resulted in accidents could have been avoided by engineering out the risks, particularly those relating to intermediate stages of deck installation and removal. Other contributing factors include unplanned changes in use and a prevalence of unsafe working practices, especially poor people-plant separation and deficiencies in edge protection.

1.4 Residual Risk

Extract from UK TWf; Publication TW17.037:

"In a temporary works design practice, procedures will be needed to eliminate hazards and reduce risks from the temporary works themselves, giving consideration to their handling, erection, use and dismantling sequences. In all cases, where there is residual risk, either the risk and its controls must be obvious beyond reasonable doubt, or else the designer must make clear where temporary works or prescribed sequences of work are needed, and what the performance requirements (e.g. strength and stiffness) of any temporary works are."

One of the key issues in determining residual risks is to distinguish between general information of which the contractor will already be aware by virtue of being a capable contractor, and "significant residual risk data" which the contractor will find of use – either in the actual construction, use or dismantling of the temporary works.

In view of the above, the residual risks to be identified on the drawings may include:

Issues that should be included as residual risks	Potential actions the contractor may take to address the residual risks
Restrictions on horizontal/vertical movements to existing assets or permanent works	The design of the temporary working platform should make allowance for these restrictions. However, the contractor may still provide monitoring equipment to verify these restrictions are met during construction.
Maximum loads to be applied to existing assets or to the permanent works	The design of the temporary working platform should make allowance for these restrictions. However, the contractor may still provide monitoring equipment to verify these restrictions are met during construction.
Limitations of lifting radius and weight for the cranes on temporary working platform	Essential information for the contractor to plan their activities. If the capacity of the cranes exceed these limitations, it is prudent for the contractor to implement visual/audial warnings or mechanical/electronic controls on the machinery to manage the risk of exceeding these limitations.
Issues related to constructability and construction methods	These should identify and communicate any assumed methods and limitations including lifting, erection and dismantling of the platform
Demarcation of areas with specific risks	It is especially important to show these areas visually to draw the attention of all readers. The drawings showing residual risks may also be posted on notice boards at site.

The communication of residual risks should be presented in the native language of the reader (typically the contractor's superintendent, site supervisor). Please refer to good practice suggested in Chapter 3 under Communication.

2 DESIGN

2.1 Design Brief

A clear design brief is essential. Ideally, this should be prepared by the designer in collaboration with those responsible for the construction, use and removal of the TSP, so that all suggestions for improved buildability are incorporated in the design. Information in the design brief shall generally include:

- Loading information such as plant data sheets (dimensions, configurations, weights, axle loads, etc.).
- Outrigger loads or track shoe ground bearing pressures and locations.
- Ground investigation information.
- Site topography and physical constraints including how these will change through time.
- Logistic plans of deck and below the deck (access and lifting zones, storage, etc.).
- Requirements for access below and around the platform.
- Duration/exposure of in-service condition.

A useful reference for the preparation of a comprehensive design checklist for a TSP is included in **Appendix A.**

2.2 Design Life

The in-service life of a TSP can vary between a few months and several years. Durability of the deck should be considered in terms of its overall structural integrity (based on limits of deformation) and the resistance of components and structural connections to chemical and mechanical degradation and fatigue loading.

Temporary platforms that will remain in position for a period of not more than one year may be designed with a reduced load factor for transient loading.

2.3 Design Loading

The TSP must be designed for all loadings the platform will be subjected to, from installation to dismantling. Accurate assessment of the loading condition must be made. A check should be made when the actual details of the loading condition are amended and a loading assumption has been used during the initial design.

The co-existing effect of different loadings must be considered to ensure the TSP structural members are adequately designed for the combined loading effects.

✔ Pictorial showing different loading arrangement on top of platform

2.3.1 Self-Weight and Imposed Load

2.3.1.1 Self-Weights

The total self-weight of the structure must be included in the TSP design, including the additional temporary works connected to it. This also includes any permanent work elements forming an integral part of the TSP.

2.3.2 Imposed Loads or Construction Operation Loading

Imposed loads on the TSP must consider those coming from construction operations mentioned below. For detailed values of construction operation loading, please refer to Cl. 17.4.3 of BS5975:2008.

2.3.2.1 Working Area

Proper allowance for access and working area loading must be considered in the TSP design. These working and access areas must be clearly marked and separated from the plant and equipment.

2.3.2.2 Storage Areas

Provision for storage loading must be clearly specified and marked on the drawings and on site. Any design limitations on the allowable height the material can safely be stacked should be clearly shown on the drawing and physically marked on site.

2.3.2.3 Pedestrian and Vehicular Traffic

Provision for loading coming from pedestrians and traffic and appropriate arrangements for the protection of vehicles and people using the TSP as an access way must be made.

When the TSP is required to be designed for traffic loading, reference should be made to Chapter 3 of the Highways Department's *Structures Design Manual for Highways and Railways*.

2.3.2.4 Static and Mobile Plant

Imposed loads coming from plant should not only include the plant weight but also other loadings it will carry and create. These subsequent loads include vibration, dynamic and impact loading.

Platform with different plant working on top

- Vibration Effects

In general, plant vibration is unlikely to cause any significant increase in loading. However, the loosening effects on bolts, wedges and other friction connections should be considered. In exceptional cases, where the vibrations are a critical factor, preloaded HSFG bolts or connections with pre-stressed high-tensile bars may be considered for the connection design.

- Dynamic Effects

This loading results from moving plant, or from loads being deposited by lifting equipment positioned on or off the platform or being carried across the platform by plant or on moving equipment. The design should allow for a horizontal force in any of the possible directions of movement.

- Impact

The consequences of impact loads should be considered in light of the damage that would result. The designer should consider all probable impacts on the structure and decide whether these impact loads be considered "normal" or "extreme" conditions for the design of the TSP. For example, the berthing load of a delivery barge used during day-to-day activities in the site should be considered a normal case and multiplied by an appropriate load factor, whereas impact by a passenger ferry operating near the construction area may be considered an extreme event. The primary framing should structurally be adequate to withstand normal impact loads without excessive deformation. For extreme impact loads, it will be more feasible to allow for plastic deformation of primary parts of the structure while ensuring no failure occurs. In such cases, the designer should consider means of replacing these members in the event of extreme impacts. Alternatively, it will be more robust and economical to resist impact loads by providing independent barriers/fenders and eliminating the risk of extreme event impacts on the platform.

2.3.3 Environmental Loads

2.3.3.1 Wind Loading

Consideration of service and typhoon wind loads must be made in accordance with the service life of the TSP. Reference can be made to the Buildings Department's *Code of Practice on Wind Effect in Hong Kong* for wind loading acting on the platform.

2.3.3.2 Temperature

For effects of temperature on the TSP, refer to Section 3.5 of *Structures Design Manual for Highways and Railways* and/or Section 2.5.6 of Buildings Department's *Code of Practice for the Structural Use of Steel.*

2.3.3.3 Earth Pressure

TSPs located on top of an excavation would usually be subjected to earth pressure loading. Main members of the platform in this area are not only designed to carry construction operations but also earth pressure loading and act also as excavation and lateral support (ELS) members. Due consideration shall be made for combined ELS and platform loadings.

2.3.3.4 Water

Marine platforms, and especially their supporting members, will be subjected to effects of water loading. These loadings include the dynamic pressure of water, impact from floating objects, and increased frontal area and head of water due to trapped debris. Reference should be made to Cl. 17.5.2 of BS5975 for this type of loading.

2.3.4 Other Type of Loads

2.3.4.1 Utility Loading

Where utilities are required to be supported from the TSP, their weight during operation and their operational requirements (such as deflection/rotation etc.) must be carefully identified and accounted for in the design. Pressure utility pipes will not only require supports for self-weight but also for the thrust force and thrust blocks weight at the pipe bend location.

✔ Utilities supported from the platform member

2.3.4.2 Ship Impact

Platforms located in the marine environment will face risks of ship impact loading. Where no specific detail for ship impact loading is defined for the project, reference should be made to Section 3.14.7 of *AASHTO LRFD Bridge Design Specifications* or CEDD's *Port Works Design Manual*.

2.4 Detailing and Planning

Careful planning and detailing is needed to ensure all TSP requirements are carefully considered and accounted for in the design. The design consideration includes fabrication, transportation, erection stage, service and dismantling stage.

2.4.1 Fabrication

Modular designs should be considered in the TSP design for efficiency in erection and re-use. Where possible, design for manufacture and assembly (DfMA) should be considered to reduce on-site work and associated construction risks. This will also provide a better quality of steelwork when fabricated in a controlled environment.

2.4.2 Logistics and Transportation

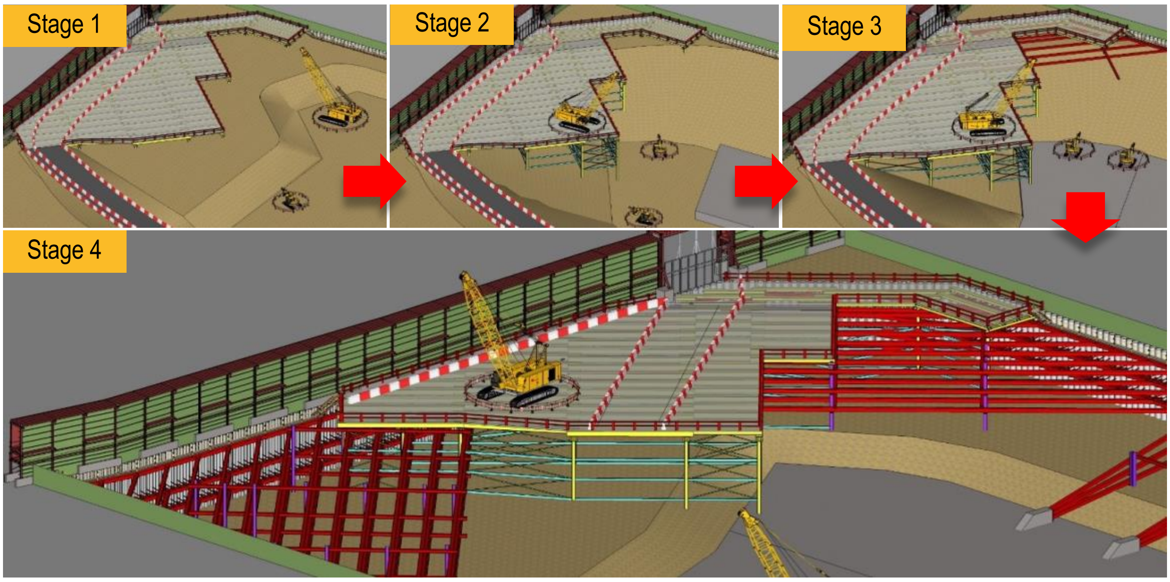
Using DfMA, the modular members of the TSP can be further designed into smaller modular members. These members can be designed and arranged in containers, optimising the space needed and cost for logistics.

2.4.3 Erection or Installation

Like any temporary works, the installation sequence must be defined showing how different modules/parts of the TSP are assembled together. The use of building information modelling (BIM) may be used in preparing the installation sequence drawings. This will not only provide the designer with a clear understanding of any design constraints and safety issues, it will also give the erection team on site a better understanding of the installation process of the TSP.

The construction stages of the platform should be clearly shown on construction drawings. If the platform is made up of many smaller parts or modules, it is favourable to include 3D drawings showing how individual components are assembled together. An example of how 3D pictorials can be used for presenting construction sequences is shown below.

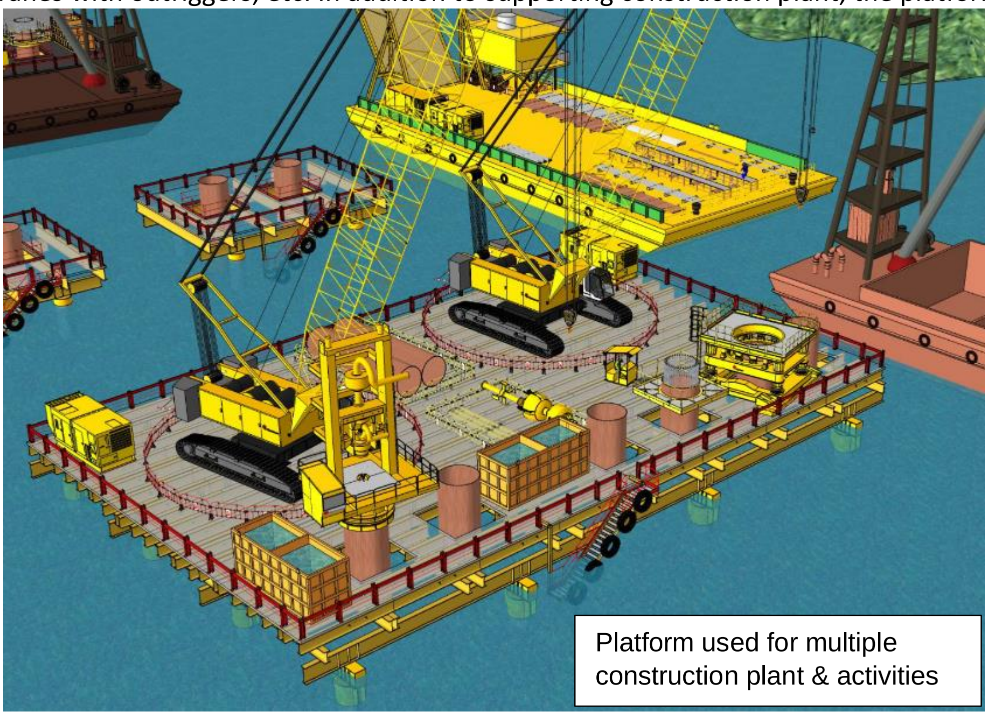
Pictorial installation sequence drawing



2.4.4 Service Condition

2.4.4.1 Space Planning

The working platform may be required to support various types of equipment and serve various purposes which may occur at the same time. Plant may be tracked and used for piling, or wheeled and used for transportation, cranes with outriggers, etc. In addition to supporting construction plant, the platform may be



Platform used for multiple construction plant & activities used for storing materials, site offices, generators and various other non-mobile construction materials/equipment. It is important to recognise the loading requirements and address the maximum deflection/vibration criteria for the plant in the design. The type of plant, its location on the platform and the operation to be carried out should be clearly shown on the design drawings.

Different activities carried out concurrently on the platform by various types of plant must be identified. Such concurrent usage requires careful planning and close integration with site management to ensure all possible uses are catered for in the design and communicated to the construction team. If there are operational constraints, these should be clearly shown on construction drawings.

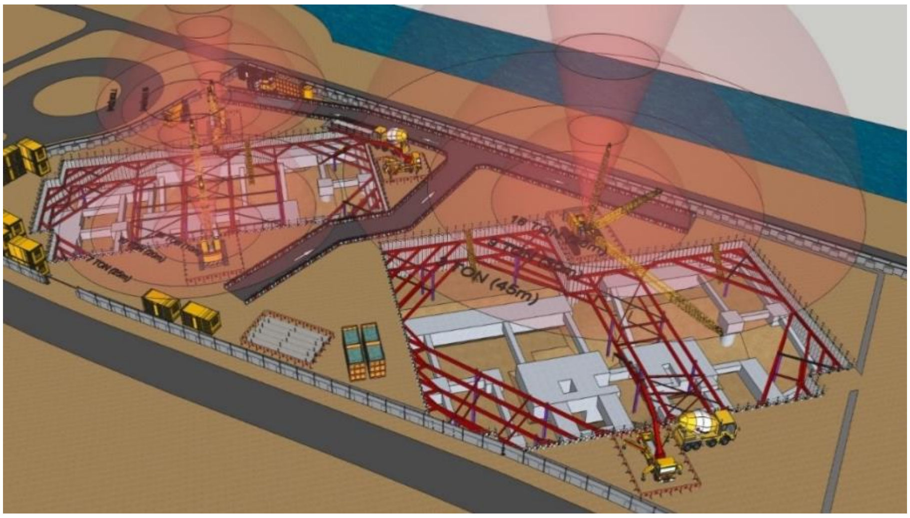
Monitoring pipes and other equipment requiring access from above and below the platform must also be considered during the entire construction stage. Safe access to the monitoring pipes must be made available during each construction stage.

2.4.4.2 Plan Layout and Sections

Preparation of the detailed drawings showing plan layout and sections of the TSP highlighting the design loading zones is essential. All equipment, monitoring points, access and openings must also be clearly identified to ensure enough space and working clearance is provided. A clear people-plant separation must be shown on designer plans/drawings and implemented on site for every construction stage.

Design loading of specific plant types, plant lifting loads or storage loading must be clearly shown on the construction drawings, highlighting assumptions in the design.

✔ 3D drawing showing the crane lifting capacity



Further illustrations with visual diagrams and images should be provided for frontline workers, shown in a language they can understand, placed in strategic locations on site, and combined with painted warnings on the platform operation zones.

Logistics plan on platform to detect clashes and check hazards from plant movement

Logistic plan underneath the platform is necessary to eliminate risks of structure instability during operations where there is a requirement to remove the ties/bracings obstructing the plant during operation

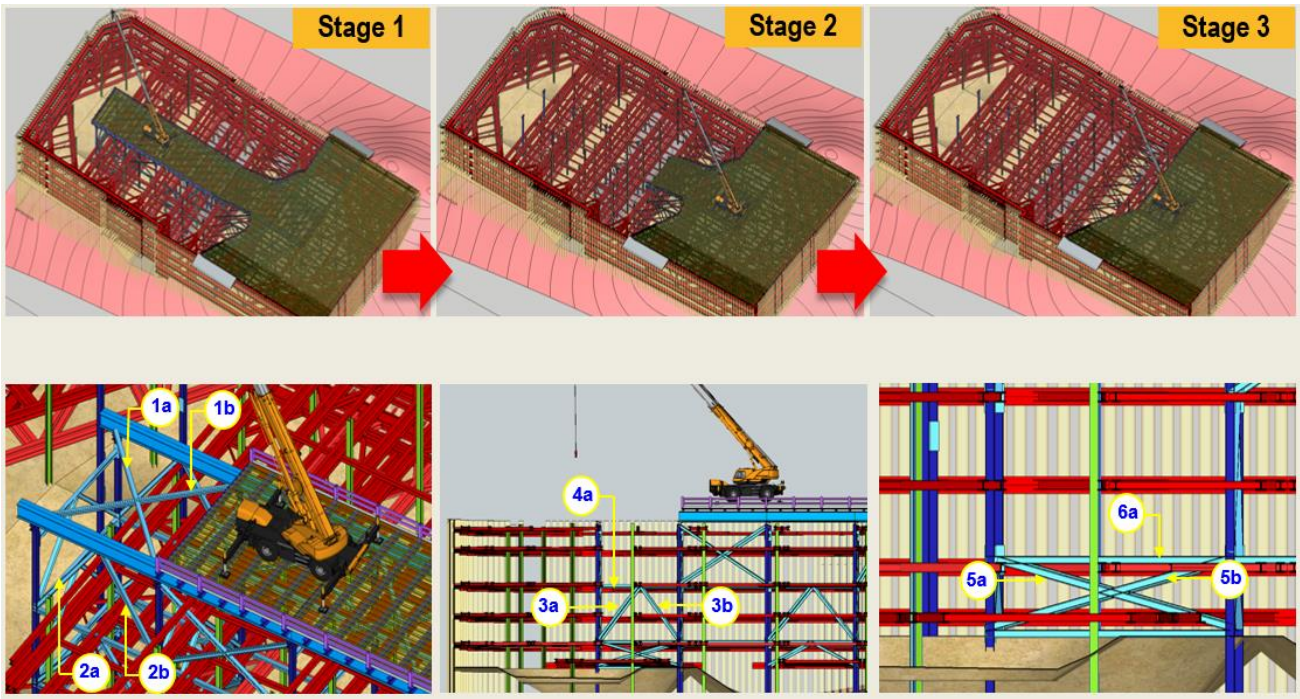
2.4.4.3 Loading Condition in Stages of Construction

Careful planning and consideration of the loading during the service condition of the TSP must be made. In some cases, deck members of the platform will also be required to take other loadings either from above, sides or below the deck level. The framing system of the TSP must be compatible for all current and future loadings.

2.4.5 Dismantling

The design of the platform is not complete without considering how it will be dismantled and removed safely. The removal may require other temporary structures to be designed such as special lifting frames or temporary bracing for the partially dismantled structure. Regardless of the complexity of the removal operation, the design drawings should have sufficient detail to describe the sequence, method and the equipment to be used.

Pictorial removal sequence drawings



The installation and removal sequence may further be illustrated using 3D models clearly describing the sequence of erection and dismantling, in turn giving assurance and confidence to all parties that the works can be carried out safely.

2.4.6 Health and Safety / Environmental Consideration

Environmental issues must also be considered in the TSP design. A surface drainage collection system must be in place. Collected water must go through a desilting tank before disposal.

Water ponding on the TSP deck must always be avoided to prevent mosquito breeding and slipping. A collection system similar to that shown below could be considered.

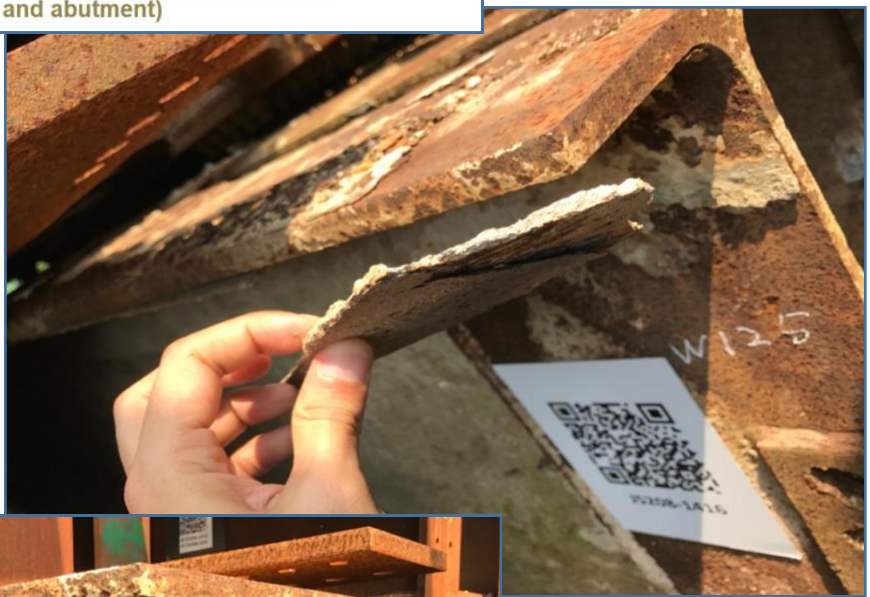
Pedestrian access on the TSP must be provided with anti-slip material to minimise the risk of injury from slipping.

✔ Drainage collection system for the platform

2.4.7 Inspection, Testing, Maintenance and Repair

It is important a robust inspection and testing regime is part of the approval requirements before using the platform. If the platform will be used for a long period of time, it is important regular inspection and maintenance is scheduled on site.

This is essential for platforms subjected to dynamic plant loading. Structural members and connections between members of the platform must be checked for any deterioration, weakening and corrosion. It may be necessary to suspend operations of the TSP until strengthening work is completed.



Delamination of steel

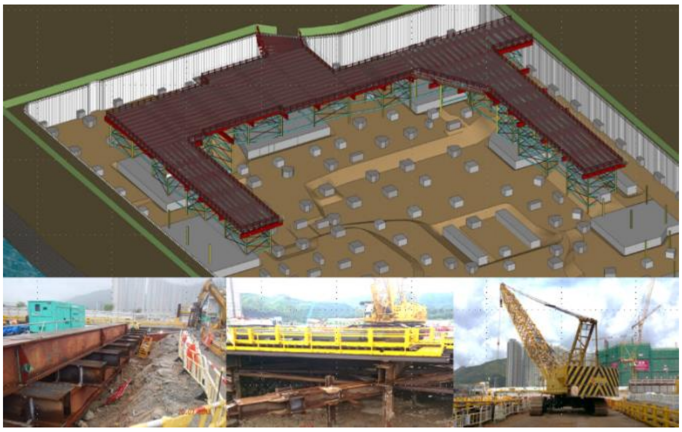
3 COMMUNICATION

3.1 Benefit of the Virtual Model

The platform-required layout and connection details can all be coordinated using BIM and 3D modelling before its actual site implementation. Interface detail in areas where small margins of error are permitted can be visualised using the virtual model to further improve the design if necessary.

The virtual model can also be used as a tool for optimising the stages of erection and dismantling works before the actual operations happen on site. This can avoid painful mistakes that might have been overlooked during the design process.

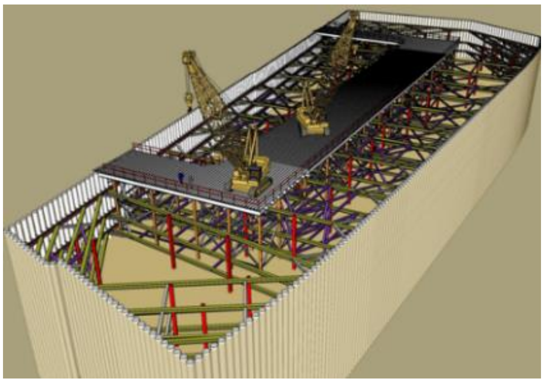
Virtual design - 3D SketchUp / BIM for clash detection



A virtual model will provide insight into construction logistics, identify and eliminate clashes and will greatly improve planning of machine movements and the provision of safe access routes for workers.

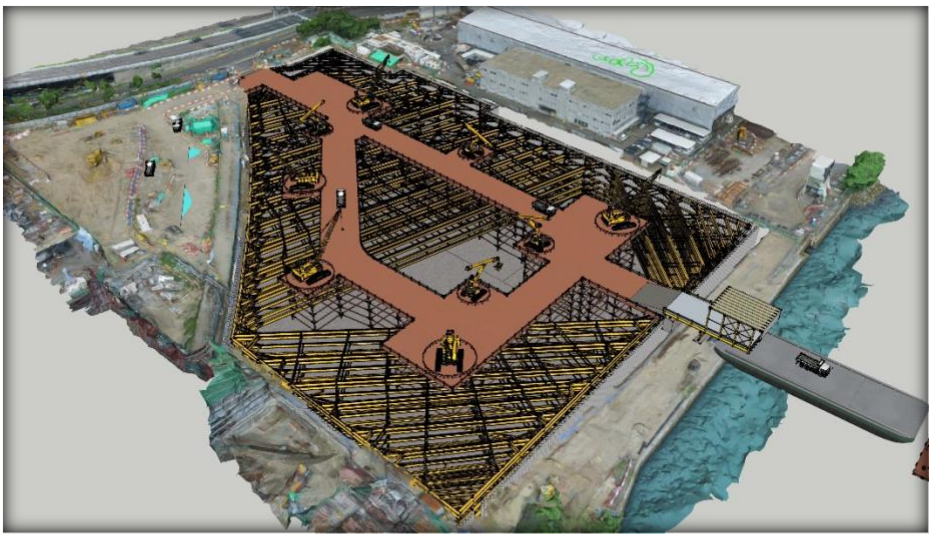
If necessary, it can also be used to identify requirements for openings on the platform and identify and eliminate any potential confined spaces.

Logistics plan on platform to detect clashes and check hazards from plant movements



Virtual model showing planning and actual condition

PLANNING



ACTUAL CONDITION

Specific plant and plant lifting load are clearly explained on drawings

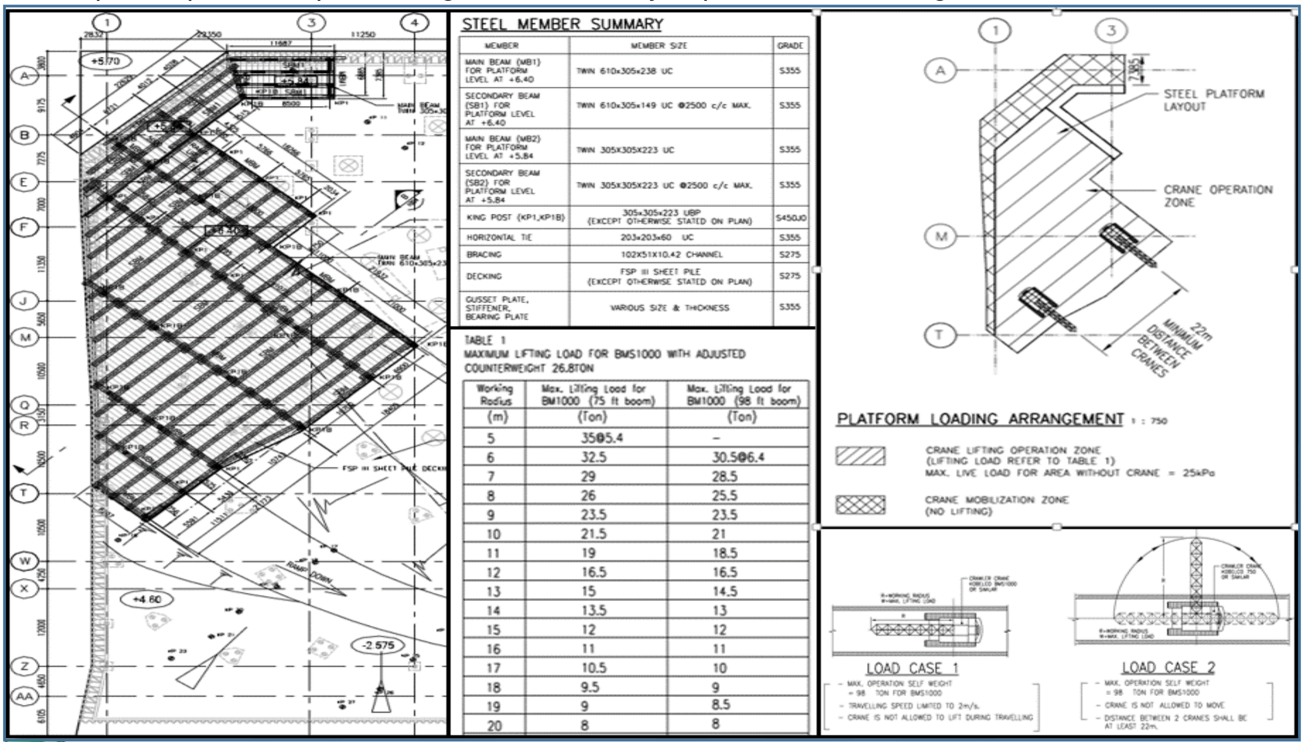
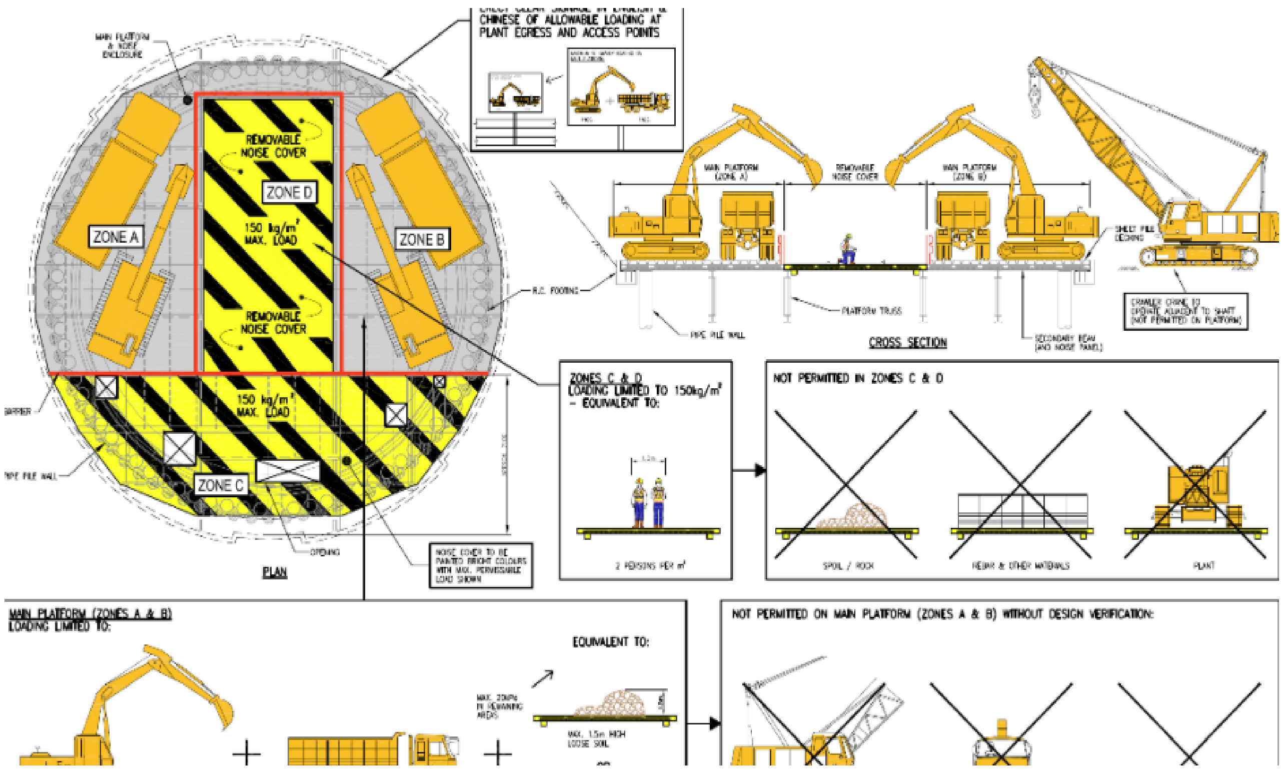
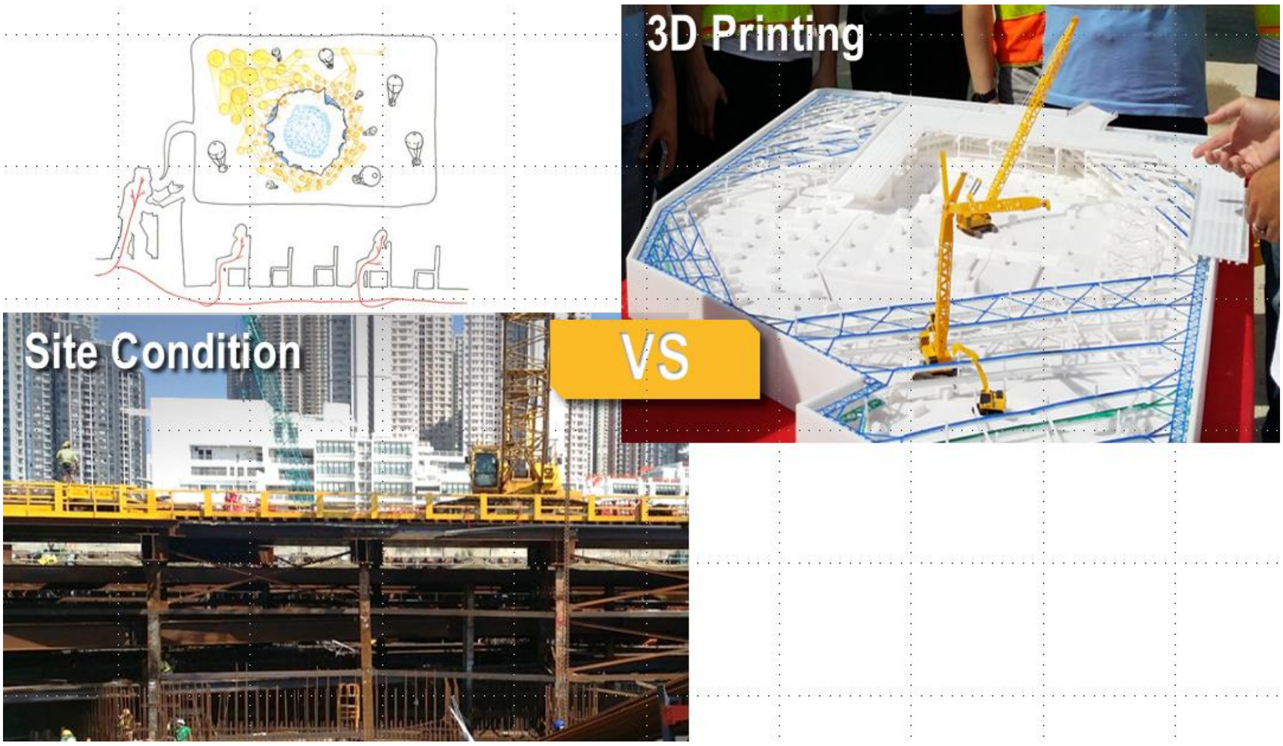


Illustration with visual images

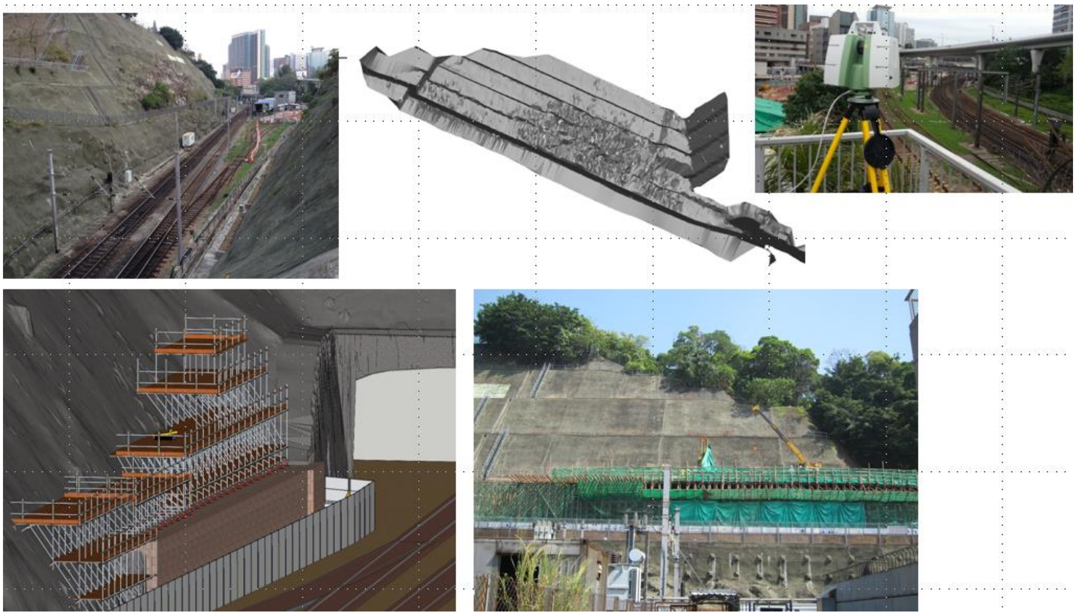


3.2 Use of Technology

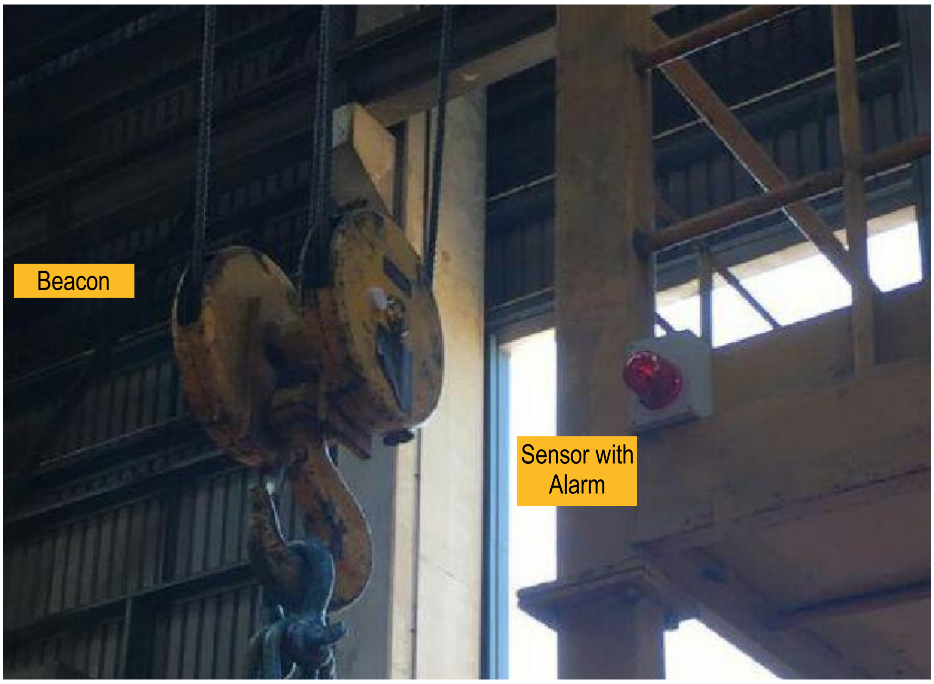
3D printed models can be used to provide and improve engagement with frontline workers. Using the 3D printed scale model, the designer can have a better understanding and appreciation of the platform and adjacent environment's condition. Having this at hand will also enable the designer to identify and improve the buildability of engineering solutions.



Laser scanning technology can be used for identifying and removing uncertainty about the site environment. This is particularly important for platforms on slopes and near existing structures with restricted access.



Proximity sensors are also a technology now readily available in the market. These sensors can trigger an alarm when it senses the signal of a beacon is inside a pre-programmed proximity radius. These sensors may be placed on moving plant/equipment to avoid clashes with other objects and structures.



Smart cameras can be placed in areas where people frequent the plant barrier. These types of technology enable an automated sensor to trigger an alarm when people enter the proximity-programmed boundary of the camera.

4 BUILDABILITY

The design of temporary platforms should facilitate their safe construction with relative ease which will also increase the productivity level of construction works, as the platform is usually on the critical path. Buildability reviews should generally be conducted by the contractor when about 50% of the design is complete.

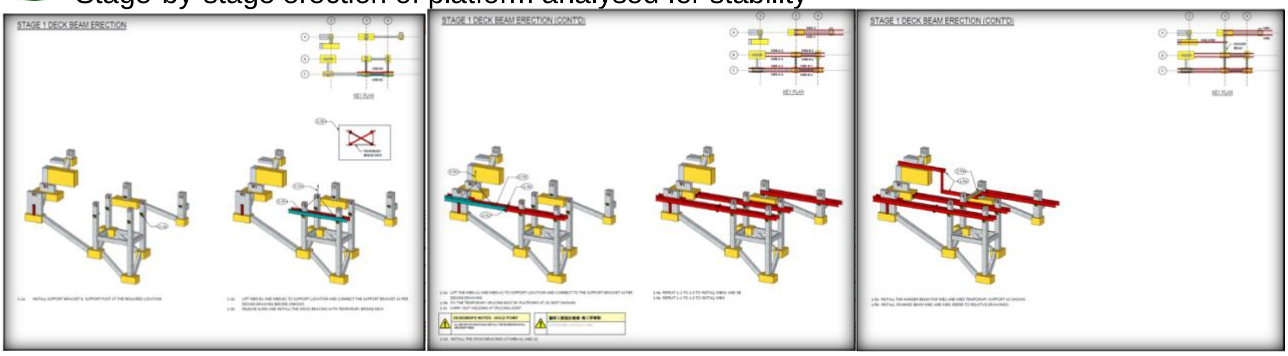
4.1 Engineering

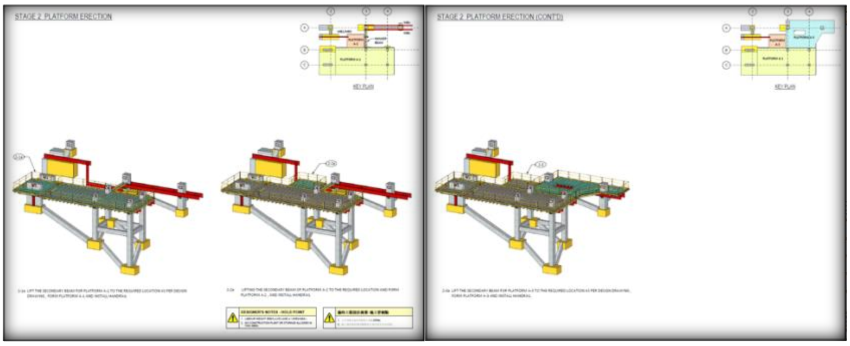
The engineer should have a good understanding of how the platform will be built, what kind of equipment and plant will be used for its construction, what other construction activities may be carried out in the vicinity of the platform during its erection and dismantling, and other environmental factors that may have an impact on the construction and operation of the platform. This information, which should be included in the design brief, will allow the engineer to address the following construction risks and buildability issues.

4.1.1 Stability of the TSP During Erection, Operation and Dismantling

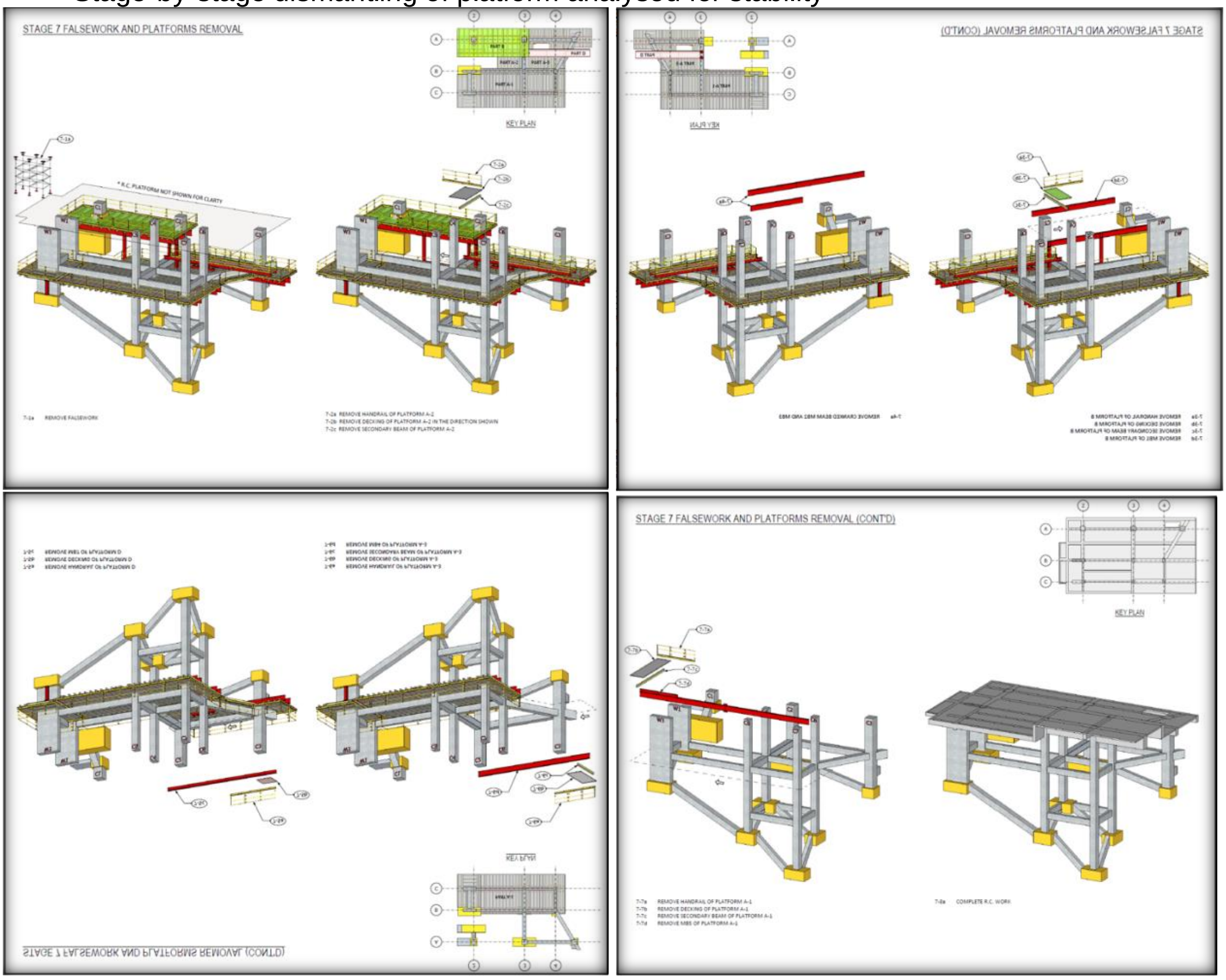
The stability of the partially completed TSP can be critical during its erection and it should be checked to ensure the structure is stable during every stage of erection. This may require temporary bracing members to be installed during various stages of erection. For example, the design of the platform beams may require the decking to be installed for lateral stability during operation. This means if the deck beams are going to be erected one at a time, they may require a lateral support during erection. If the erection stages are well thought through, the designer can specify the beams to be installed in pairs with the bracing between them, as shown in the figure below, which will eliminate the risk of the beams toppling during erection.

Stage-by-stage erection of platform analysed for stability



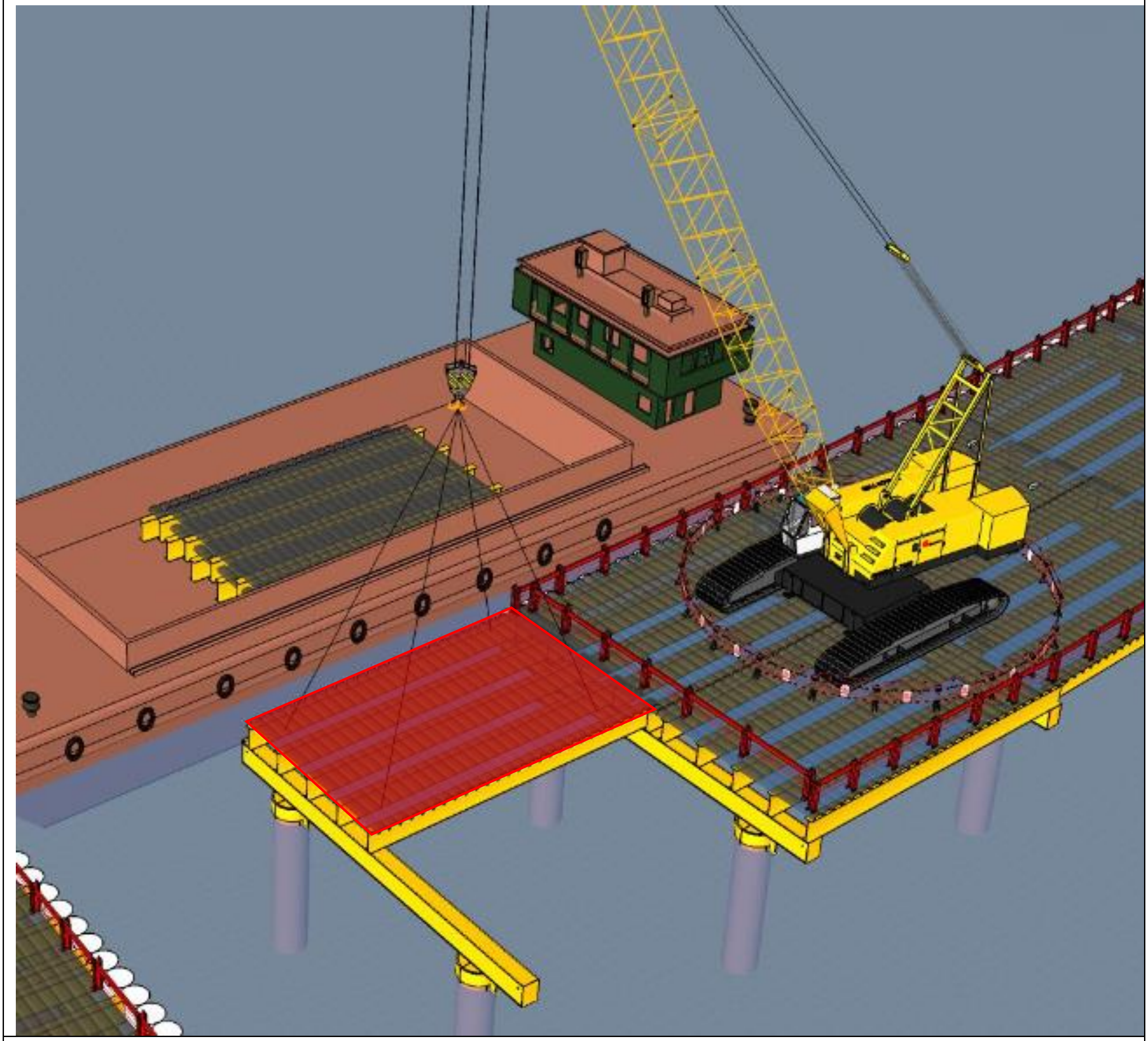


Stage-by-stage dismantling of platform analysed for stability



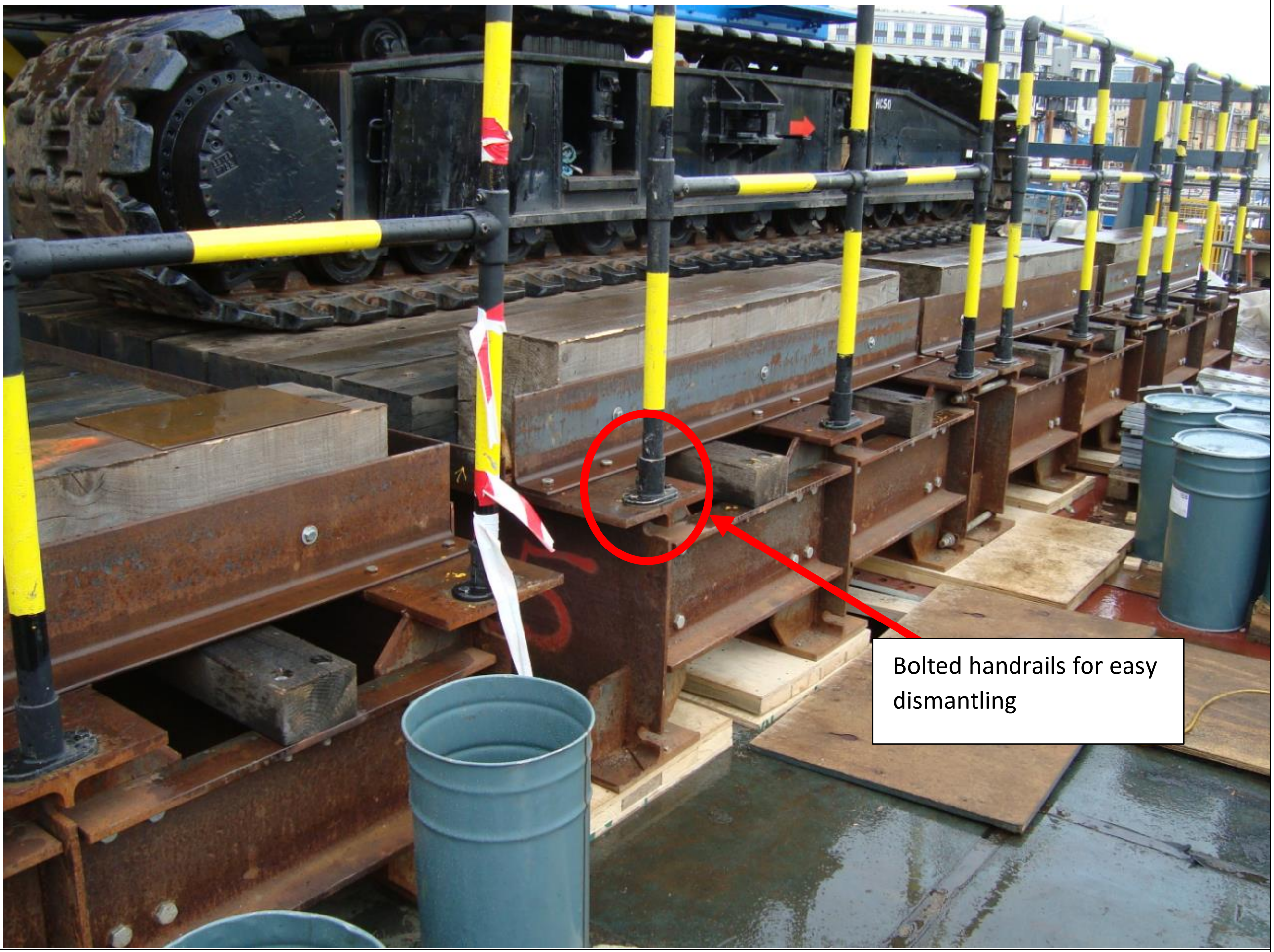
Alternatively, the platform may be designed as modules with decking pre-installed off-site. Erection with modules may require different delivery routes, greater on-site storage area and higher capacity lifting plant. Therefore, the engineer and contractor should work together to ensure these constraints are considered appropriately in the design.

During dismantling, it may be necessary to connect the TSP to the permanent structure prior to part-by-part dismantling of the platform. In such cases, the method of removing or leaving connections embedded in the permanent works (sockets, post-fix anchors etc.) and the type of material to be used (e.g. stainless steel, galvanised etc.) should be duly considered. If the platform will not be reused, it may be dismantled as individual modules or as a single module that can be cut into smaller pieces for removal if the lifting plant and space planning makes these options feasible.



Dismantling of marine platform in modules

The secondary structural members should ideally be connected to primary members with bolted connections to allow for easy installation and removal as separate units.



Removal of secondary structural members

4.1.2 Erection Tolerances

The designer should clearly show maximum allowable erection tolerances for structural members such as verticality and position of piles/kingposts, accuracy of location on plan and level of deck graphically on the design drawings to ensure they are communicated with the frontline staff properly. Where possible, the designer should also provide actions to be taken if the tolerances are not met.

METHOD STATEMENT FOR LEVEL ADJUSTMENT OF PLATFORM/ACCESS BRIDGE

WHENEVER THE GRADIENT OF THE PLATFORM OR THE DIFFERENTIAL SETTLEMENT BETWEEN ADJACENT PILES EXCEEDS THE SPECIFIED VALUES IN THE ABOVE TABLE, REMEDIAL MEASURE FOR LEVEL ADJUSTMENT OF THE PLATFORM/ACCESS BRIDGE DECK IS REQUIRED.

(a) ACCESS BRIDGE:

(i) POSITION THE CRANE AND SECURE THE STEEL BRACKETS OF THE CROSS TRUSS–BEAM TO THE CRANE.

(ii) REMOVE THE SHEAR CONNECTION PLATES AT THE PILE HEAD.

(iii) LIFT UP THE DECK TO THE REQUIRED LEVEL.

(iv) CONNECT THE PILE TO THE CROSS BEAM DETAILS AS PER DRAWING J2939–110/117.

(b) PLATFORM:

(i) REMOVE ALL LIVE LOAD ON THE PLATFORM.

(ii) WELD THE TEMPORARY BRACKETS TO THE PILE WHICH REQUIRES LEVEL ADJUSTMENT.

(iii) DISCONNECT THE PRIMARY BEAM FROM PILE AND INSTALL 5 TON JACK (TOTAL 2 NOS.) ON THE BRACKETS.

(iv) JACK UP THE DECK TO REQUIRED LEVEL.

(v) INSTALL STEEL PACKINGS(STEEL PLATES OR UC) BETWEEN PRIMARY BEAM AND PILE HEAD.

Description of corrective measures for out-of-tolerance member

4.2 Durability

The designer should assess if the TSP will be exposed to extreme conditions and consider durability requirements in the design. When exposed to harsh conditions such as salt water, paint protection should be considered. A supporting king post of the TSP with traffic underneath the excavation should be considered an extreme load condition and risks for progressive collapse checked.

5 STANDARDISATION

5.1 Systemised Construction

The Construction Industry Research and Information Association (CIRIA) defines standardisation as 'the extensive use of components, methods or processes in which there is regularity, repetition and a background of successful practice'. One of the keys to success of a temporary platform construction is good standardisation so that works can be executed in a controlled and repetitive manner.

The members of the TSP must consist of modular sections where possible. One of the advantages of having a modularised platform is provision for pre-defined lifting points. This makes the repetitive installation and removal activities safer.

Modular sections showing modular panels prefabricated and installed on site.

5.2 Selection of Structural Layout

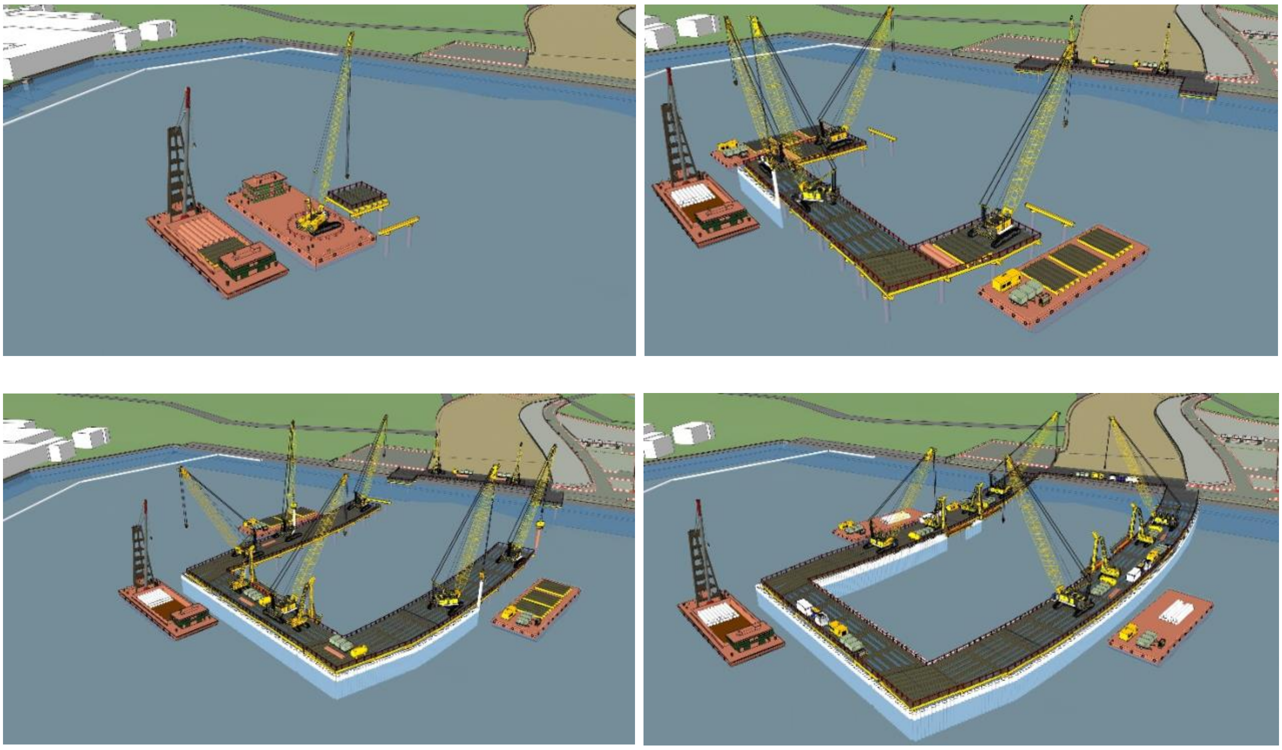
The structural design of the platform should start with the selection of a structural grid system that allows fabrication of standard-size units at the factory and assembly as standard components at site. The maximum reach and limiting weight of the erection plant, availability of storage at the site and transportation restrictions should all be considered when selecting the structural layout.

5.3 Repetition of Construction of Activities

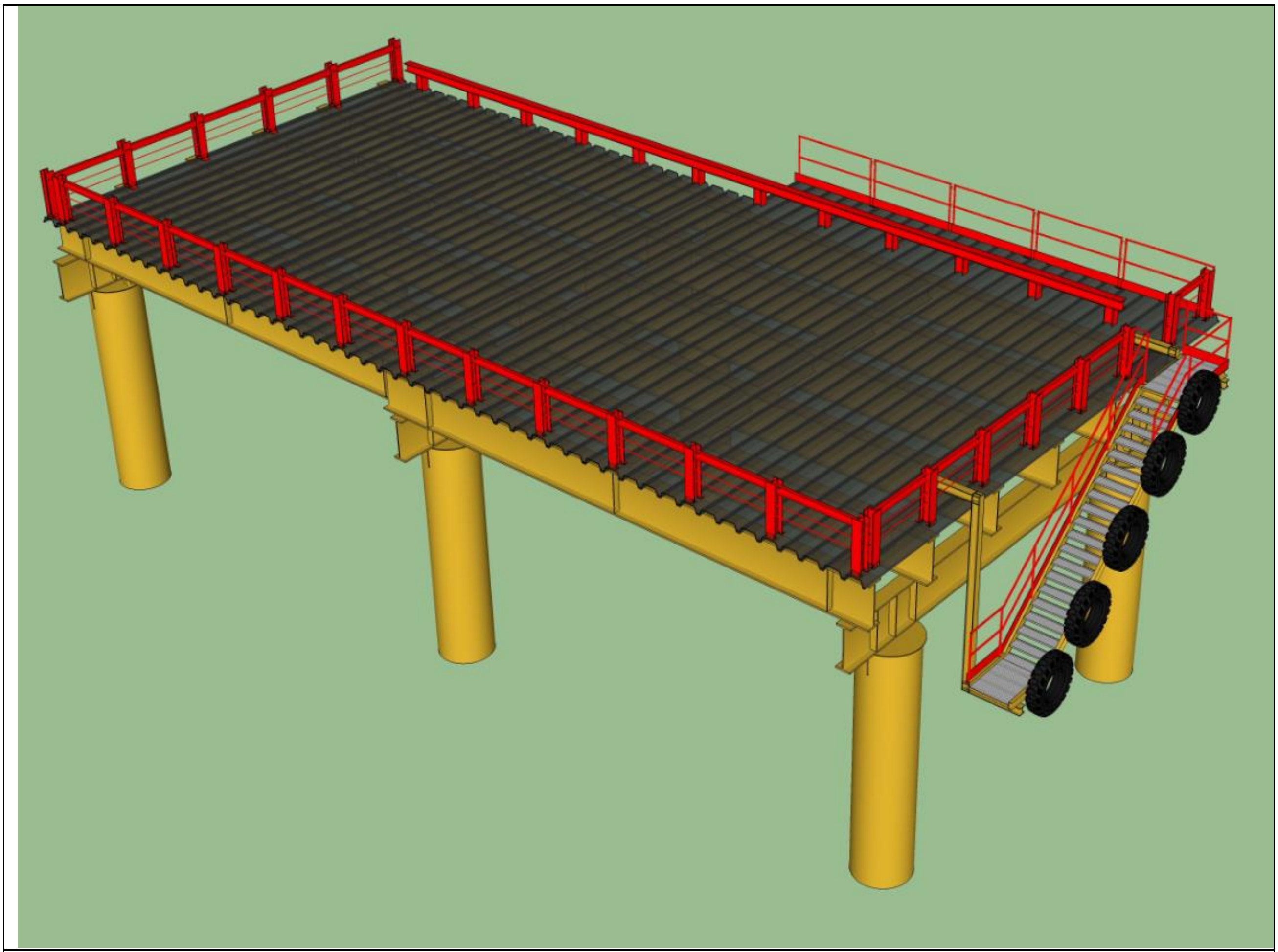
A suitably selected structural grid will allow repetition of the construction processes. Repetition reduces the chance of construction mistakes and accidents, as well as material waste.

A typical construction sequence below shows the installation of the first bays of a marine platform from a derrick barge. The operation starts by installing the pipe piles followed by installation of a cross beam across the piles with sleeve connections. The construction activity is repeated for the next grid line. This example shows the design of the deck is made up by deck modules. The deck area is divided into two equal widths which allows the same modules to be installed one after the other. Making the modules identical has the added benefit of reducing construction planning and maximising opportunities for re-use.

Repetitive installation sequence



The principle of "repetition" should be adopted throughout the construction of the platform and includes installation of handrails, vehicle barriers, deck openings, lateral bracing members etc. Each of these components should be designed and detailed in such a way that their installation and removal methods follow logical and practicable steps.



Platform with modular staircase and pre-installed tyres for impact

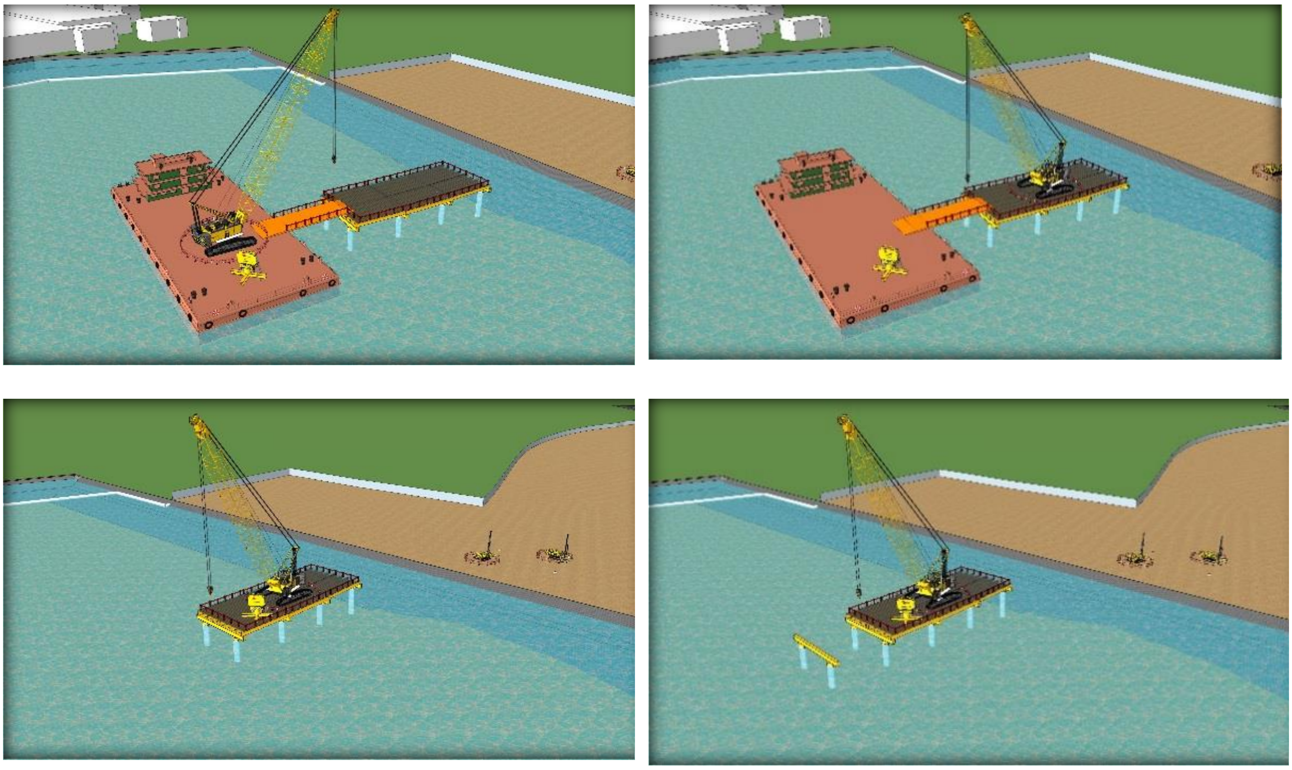
5.4 Use of Construction Plant for Erection of Platform

In the example above, installation of the platform requires marine plant, as construction is away from land. However, it is preferable to adopt wherever possible land equipment working off a robust platform instead of using marine plant, for better stability and control of movement. Therefore, the design of the platform should consider installation of land plant on top of it to continue and extend the platform.

In addition to the safety benefits of using land plant, the modules of the platform can be more accurately placed compared with using marine plant.

An example is shown below where the construction of a marine platform is extended after an initial island platform is constructed using marine plant. A similar principle may be applied to installation of platforms on land. It may be advantageous to design the platform structure so that the installation can be carried out using a tower crane at site, instead of designing large modules that may require mobilisation of additional mobile plant. Each new plant will create additional congestion at site and increase construction risks related to plant operations.

Initial platform used to support equipment for platform extension.



The erection of the initial platform should be carefully planned in order that the same platform can be used to erect the adjacent platform.

5.5 Installation of Secondary Structural Members

The design of the platform will not be complete without making provisions for installation of secondary structural members. These members include walkways/vehicle barriers, stairs, cat ladders, handrails, framing around openings, guide frames etc. It may be feasible in some cases to pre-install these on the deck modules, however, one should also consider the potential damage of such components during transportation and placement.

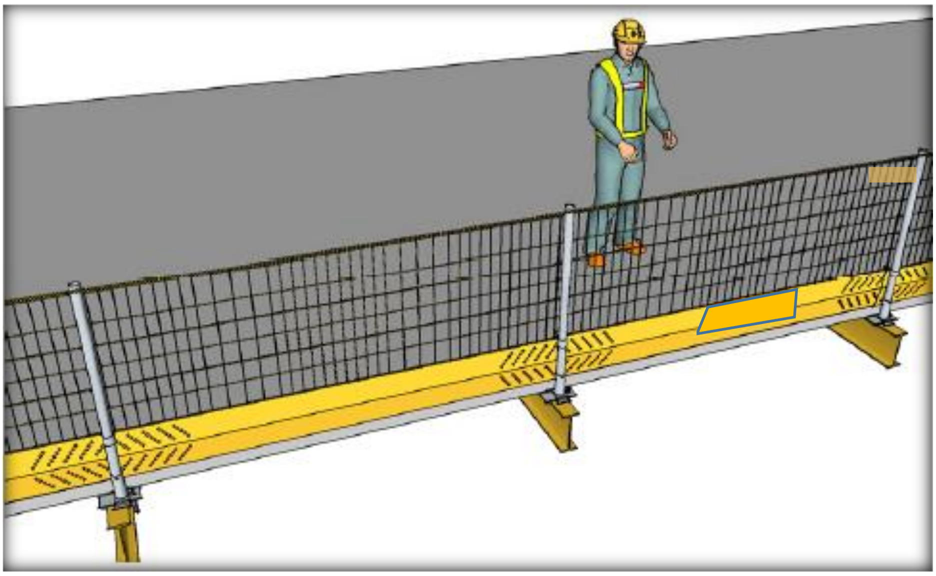
Vehicle barriers on temporary platforms are typically made of universal column (UC) members with welded or bolted connections which makes them reasonably strong and able to withstand impacts that may occur during transportation and placement. However, the handrails are typically slender circular hollow section (CHS) members with nominal connections. It may therefore be prudent to avoid handrails being pre-installed at the factory unless one can ensure there would be no damage during transportation and placement. If the connections are going to be made at the site, they should be designed to be bolted as far as practically possible, as opposed to site-welded connections. Brackets may be welded at the factory directly on the main structural members so that the secondary members can readily be bolted at site.

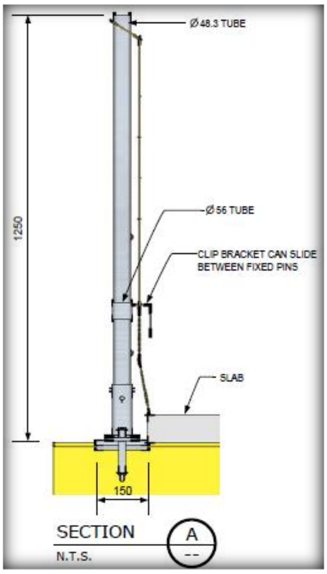
Delivery of pre-assembled modular components are in general preferable due to safety and production rate benefits. In cases where pre-assembly is not practicable, the designer/contractor should consider trial fitting individual components in the factory prior to delivery.

5.6 Standardised Safety Features

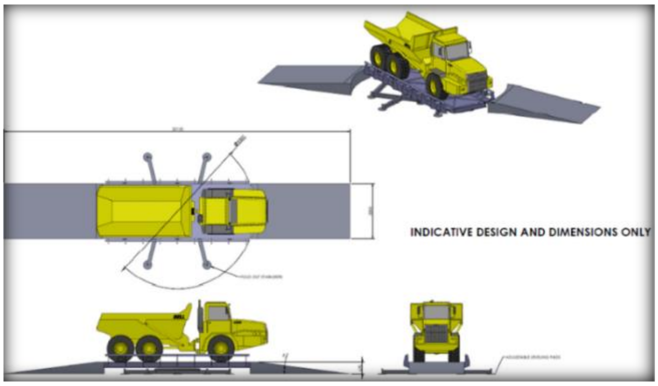
Use of standardised safety features will not only enhance safety but also improve consistency across the industry.

✔ Standard edge protection will ensure robustness in the design, protecting workers by preventing falls from height and providing separation from construction vehicles.

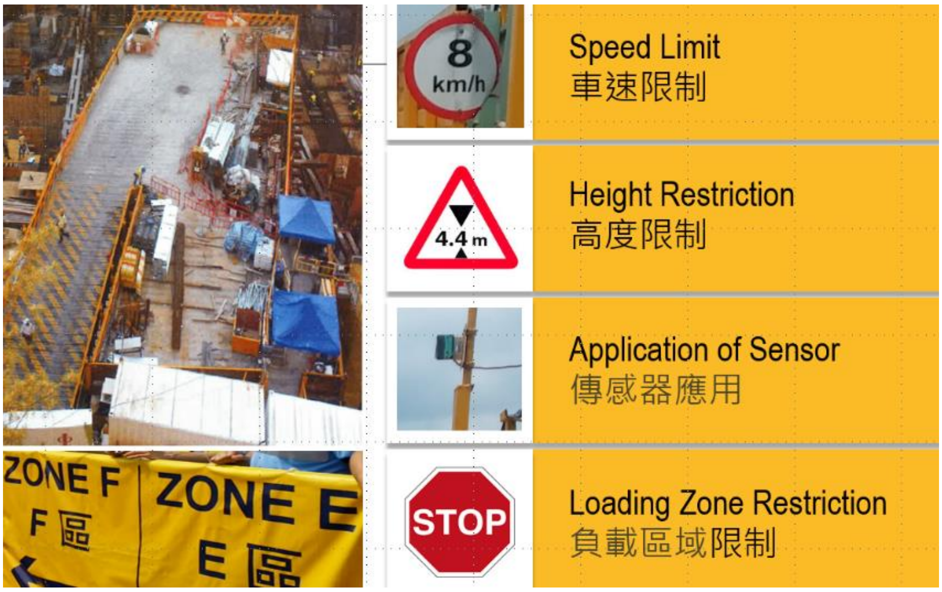




Use of turntables. With limited space provided for platforms, risk from restricted movement of vehicles can be resolved using a turntable. A turntable provides safe movement of vehicles in limited space and avoids reversing which can be a significant hazard.



Standardised signs board and sensors will greatly improve consistency across the industry.



6 SOURCES OF ADVICE AND INFORMATION

1. UK Temporary Works Forum, www.twforum.org.uk
2. Hong Kong Temporary Works Forum, www.twforum.org.hk
3. BS 5975 *Code of practice for temporary works procedures and the permissible stress design of falsework*.
4. Highways Department, *Structures Design Manual for Highways and Railways*.
5. *AASHTO LRFD Bridge Design Specifications*.
6. Buildings Department, *Code of Practice for the Structural Use of Steel*.

Appendix A – TSP Designer Checklist

Temporary Steel Platform (TSP) Designer Checklist							
Project Ref.: **Title:** **Design Package:**	**Design stage & color code for required checks**						**Designer:**
	Tick (✓)	Conceptual design:	(green)	*only*			
		Preliminary design:	(green)	+	(yellow)	*only*	
		Detailed design:	(green)	+	(yellow)	+ (orange)	**Date:**

This form may be used as a self-check by the Designer to help ensure that engineering risks are systematically considered. It shall be used in conjunction with a full risk assessment carried out in collaboration with the Construction Team.

This is a live document. Other detailed/specialist aspects or details may also need to be considered to suit specific project issues.

Specific action by Designer is required if any of the right margin boxes is ticked 'No'.

	Item	**Yes**	**No**
1.	**Purpose of TSP & Design Brief**		
1.1	Is the TSP actually required and is it the best way?		
1.2	Are the design brief and allocated design time sufficient for us to carry out and clearly document the design, and prepare clear general arrangement drawings highlighting constraints *(including those from item 3.5)*, adjacent works, interfaces and staging?		
1.3	Loading: Is there a clear load path? Any possibility of *change* in loading conditions during use, potential impact loading, unexpected (or variable)/accidental loading, actual plant loading, and corrosion/damage due to use/vibrations considered?		
2.	**Design concept – Making it easy to build**		
2.1	Design & construction options - Is this the best method of working? *(Always consider off-site prefabrication and systemized construction whenever this can aid safe working.)*		
2.2	Site visit done by Designer? (Preferably with the PM or frontline staff responsible for arranging the site works.)		
2.3	Safety and Operational reviews - Input from with PM / Construction Team on build-ability? For critical/complex TSP, method workshop with sub-contractor's participation held?		
2.4	Has the entire construction cycle been considered? (Erection, operation/maintenance/repair and removal/dismantling or demolition, with suitable provision of safe access and working space *at each stage*.)		
2.5	All design & construction interfaces and staging, including *hold points,* catered for?		
2.6	All associated TW planned & designed? (e.g. safe working platforms for installation of other TW)		
2.7	Design with optimal use of standardized solutions such as man-access stairs, safety handrails and crash barriers?		
2.8	Testing and inspection requirements fully specified on the drawings and practical?		
2.9	TSP design aligned with method and programme(s) for design approvals, procurement / fabrication and construction?		
3.	**Removing Risks - Anticipating Changes - Design Robustness**		
3.1	Fatal risks or common causes of accidents to be removed by engineering considered? (✓) ☐ Working at height ☐ Electrocution ☐ Confined spaces ☐ Separation of moving plant and people ☐ Trips & falls ☐ Accidental loading? ☐ Falling objects ☐ Fire hazards ☐ Progressive failure? ☐ Drowning / construction over water ☐ Construction over existing assets? ☐ Risk to the public?		
3.2	Virtual TSP model and clash detection done for complex works? (Using Google Sketch up (3D) or BIM)		

3.3	Has the design considered project specific constraints and the surrounding environment, and how these may *change* during the works? Use of laser-scan or photogrammetry to understand the built environment.		
3.4	Temporary Traffic Management scheme (if required) detailed and practical? - Avoid reversing vehicle; - Plants and workers segregation – allow realistic working space with protection barriers; - Crane position/access or lifting capacity of the crane at different radius; - Provide skid resistance on deck access ramp if any.		
3.5	Impacts from, or onto existing buildings, structures, utilities (buried or *overhead*), roads, slopes or retaining walls, natural terrain, etc. mitigated and found to be acceptable?		
3.6	Vertical support members – designed for impact loading at delivery openings / mucking out holes. Access route below deck – protection of supports and clear of bracing.		
3.7	Have floor / platform openings for material delivery/mucking out (if any) been properly engineered to avoid dislodging or hatches? Adequate edge protection or other features increasing safety of access & construction designed and clearly specified?		
3.8	Heavy lifting (if any): - Have the work process and equipment required been duly considered? (Including any requirement for a foundation so as to avoid failure of support and minimize risk of settlement.) - Is the provision of lifting points on prefabricated elements, and the weight and centre of gravity of heavy or bulky items specified on the drawings? - If a prefabricated structure is required to be temporarily suspended for a period of time before final installation, are there means to ensure the hazards arising are removed (or risks mitigated)?		
3.9	Design compared with previous similar designs, and lessons learnt / near misses from previous projects duly incorporated?		
3.10	Design robustness - Is the scheme adequately tolerant of: - Reasonably foreseeable changes of functional brief, interfaces, loading, groundwater or ground conditions? - Reasonably foreseeable changes to programme and staging, or other site conditions? - In the event of accidental loading, how might the TSP fail, and how could this be prevented? Protection of critical elements? In addition, has potential progressive collapse of the TSP been prevented by design? Note: if '**No**', the Designer action may include conveying the constraint to the Site Team so that residual risks can be effectively managed.		
3.11	Instrumentation & monitoring requirements specified? (Note need for regular data review.)		
3.12	Specialist design by others (if any) reviewed and acceptable?		
3.13	Risk of incorrect assembly or use of incorrect element size / length minimized by design, with clear directions provided on the drawings? *(Also, does the design include specification of clearances/tolerances required for construction and techniques, and features to aid safe alignment and initial connection of structural elements?)*		
3.14	Practical design of safety features? *(e.g. anchor points for installation of life-line or safety harnesses)*		
3.15	Removal of elements under load fully detailed? *(e.g. for ties or bracing)*		
3.16	Detailed checklist(s) for inspection of pre-fabricated units communicated to Site Team?		

4.	**Communication of Design Intent**		
4.1	What are the key safety points and stages of construction, and key aspects for frontline staff responsible for construction to look out for? *(To be noted below or on a separate sheet. Consider the findings from Item 3.9.)*		
4.2	Will the drawings be easily understood by frontline staff responsible for construction?		
4.3	Allowable loading clearly shown on the drawings? - Loading key plan or design loading condition/criteria; and - Allowable loading / surcharges & plant position? (To be specified in *pictorial* format.)		
4.4	Work procedure drawings done? Consider: - Clear and unambiguous pictorial step by step sequence and associated engineering control / communication of safety information (e.g. hold points & residual risks; designer's advisory notes; precautionary measures and contingencies); - Working space and materials delivery during erection of platform (where do workers stand and can they build/dismantle safely?); - Signage and marking on deck to show worker and plant access/egress and segregation, access route, "No-Loading" zone, designate storage area, etc… - Any utility or excavation crossing points required?; - Starter bar / edge protection; - Use of colour drawings where beneficial to safety; - 3D views / BIM for complex works; - Any requirement for a particular permit to work system (e.g. for confined spaces / tunneling)?		
5.	**Final review / conclusion**		
5.1	Peer review carried out?		

Next step: Address any arising issues & confirm proposed final design with PM / Construction Team.