1.0 INTRODUCTION

1.1 General

Design and construction of working platforms for heavy tracked equipment is a high risk and often poorly understood activity.

Despite working platforms being necessary for almost all construction sites, currently in New Zealand, there is no definitive, local guidance for the design or construction of temporary working platforms. While some refer to the British guidance (BRE 470) or TWf 2019:02, this lack of definitive guidance has led to significant variance in methods used for working platform design.

There is also a range in quality of materials and construction methods being used throughout the industry. When all these variables are combined it leaves the industry open to the risk of platform failures and potential harm to personnel and damage to plant.

Working platform design should be undertaken by a competent person (Temporary Works Designer) who understands how loads are applied to and resisted by the subgrade and working platform. Information on the assessment of the competency of the Temporary Works Designer (referred to from here on as the Designer) can be found in the Temporary Works Procedural Control Good Practice Guideline (TWfNZ GPG01:19). This document provides guidance on good practice on temporary works procedures and the roles and responsibilities of those involved with the design, procurement, construction and use of temporary works.

The Temporary Works Co-ordinator (TWC) is critical to the implementation of good temporary works procedural control. Further information on the role and responsibility of the TWC can be found in the Good Practice Guideline.

1.2 Purpose

The purpose of this Technical Guidance Note (TGN) is to provide the reader with an overview of existing available guidance documents and current best practice guidance with regards to the design, construction and use of working platforms for construction plant and equipment in New Zealand. Typical plant and equipment include tracked cranes and piling rigs as well as mobile cranes and hiabs with outriggers. Application of this guidance to other types of plant should be assessed on a case-by-case basis by a suitably competent and experienced designer.

This TGN will not detail how to derive loads or actions from plant or calculate the thickness of a platform but instead will make the reader aware of the existing best practices as well as assist with risk identification and management in line with the TWf(NZ) GPG01:19 Temporary Works: Procedural Control Good Practice Guideline.

It will also provide guidance on construction and maintenance of platforms and the use of local materials and inclusion of reinforcement such as geogrids.

2.0 CURRENT REGULATORY REQUIREMENTS

2.1 Health and Safety at Work Act 2015 (HSWA)

The HSWA sets out the principles, duties and rights in relation to workplace health and safety. Under the HSWA all Persons Conducting a Business or Undertaking (PCBU's), whether they are owners, designers, constructors or users of the works, have a primary duty of care to ensure a place of work is safe for workers and others. There are overlapping duties for Main Contractors, Subcontractors and Consultants. All parties are expected to fulfil their duties as a PCBU in accordance with the HSWA.

Robust design and construction of working platforms is a requirement under the HSWA in that it would be considered a reasonably practicable step to ensure that an item of plant or equipment was sufficiently supported to avoid tipping over and injuring workers

2.2 Resource Management Act

The design and installation of temporary works will often require compliance with project specific resource consent conditions. In the case of working platforms this will often require the review of earthworks consent conditions such as volume restrictions and contaminated fill disposal requirements. It is important to review and understand these consent conditions before designing and installing a temporary working platform.

2.3 Building Act and Building Code

The design of a temporary working platform is unlikely to require a building consent, however it should meet the requirements of the building code. A competent judgement decision must be made by the Designer and/or Temporary Works Coordinator as to whether the consenting authority (council) should be asked if a building consent is needed or not.

Exceptions to this could be where excavations or filling are required adjacent to boundaries and these works require temporary retention works. These types of temporary works are outside the scope of this guidance document.

3.0 EXISTING AND INTERNATIONAL STANDARDS AND GUIDANCE

3.1 General

There are a number of internationally accepted methods for the design of granular working platforms. The most commonly used are:

- BRE 470 – Available for purchase from the Building Research Establishment (UK).
- TWf 2019:02 – Available as a free download (at time of printing) from the Temporary Works Forum (UK).

3.2 BRE 470

BRE470 (BRE 2004) provides guidance on good practice for the design, specification, installation, operation, maintenance and repair of working platforms. The BRE470 method for working platform design is widely used in the New Zealand construction industry. It is commonly considered as a safe and reliable method to design working platforms for tracked plant.

Key aspects of the BRE470 method include:

- The consideration of two load cases:
    - Case 1 loading applies to conditions in which the plant operator is unlikely to aid recovery from an imminent platform failure. Examples are travelling, standing or lifting;
    - Case 2 loading may apply when the plant operator can control the loading safely. Examples of this could include installing casing, drilling, extracting as auger and extracting casing. Lower load factors apply to Case 2 conditions;
- Loading is applied as a rectangular uniformly distributed load, based on effective track length and width;
- The method relies on classic bearing capacity calculations for the substrata, however, it uses punching failure as its main resistance mechanism in the platform material, instead of load spread (Fig. 1);

- No overburden effects from the surcharge and platform fill are considered on the bearing capacity assessment;
- Deformations are not directly considered. Instead, deformation limits are deemed to be satisfied by checks on bearing capacity;
- Strength reduction factors on the platform and substrata properties are proposed as unity, so that design values are equal to characteristic values;
- The method applies to uniform substrata only, which may require averaging (when appropriate) or selection of lower bound values if multiple soil layers exist;
- Calculations are provided for both cohesive and granular substrata conditions;
- For cohesive substrata, it is noted that the punching shear failure mechanism only applies for substrata with 20 kPa < cu < 80 kPa. For undrained shear strength cu < 20 kPa the ground will be too soft and more sophisticated types of design calculations are required. For cu > 80 kPa the bearing resistance is deemed to be sufficient to general support construction plant without the design of a working platform; and
- Geosynthetic reinforcing is considered to provide additional vertical restraint at the punching perimeter, instead of providing additional lateral restraint.

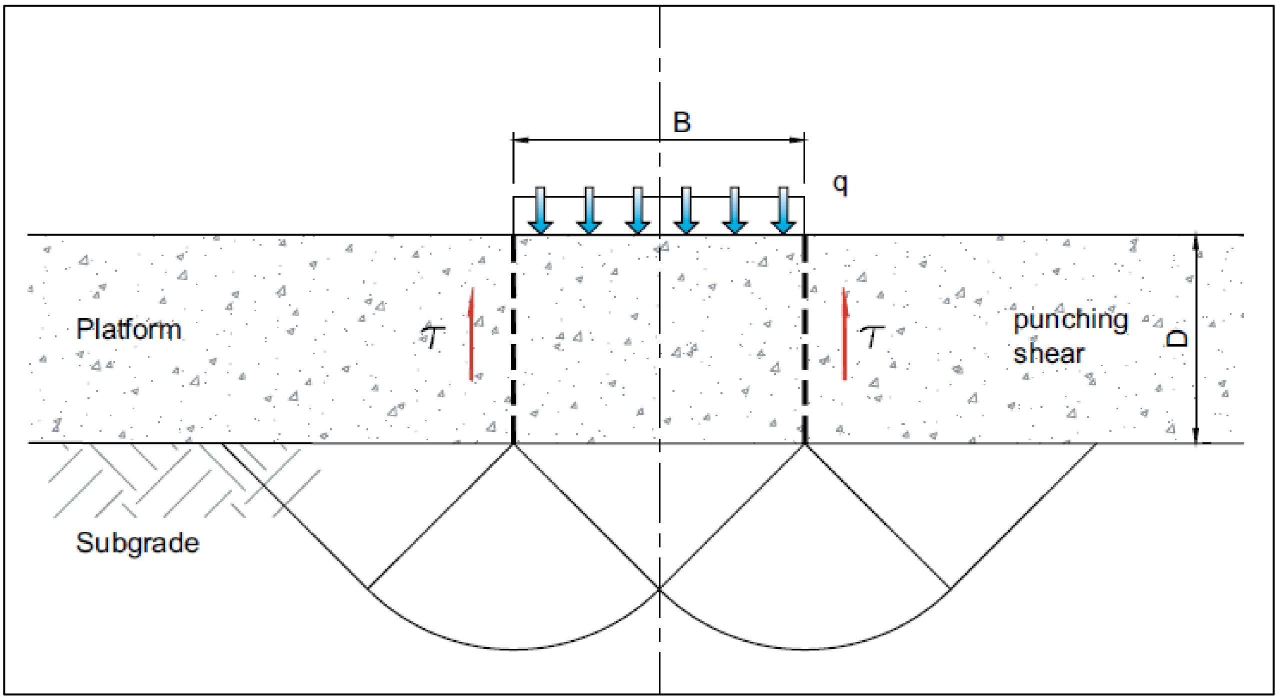

Figure 1: Shear resistance due to punching failure as per BRE470 method (Temporary Works Forum 2019)

3.3 TWf2019:02

The published TWf2019:02 (Temporary Works Forum 2019) method proposes an alternative method to BRE470 to comply with Eurocode 7 (EC7). The method is discussed in detail in the document and will not be reiterated here. In summary, a few key aspects of the method include:

- Design actions are derived in accordance with EC7;
- Partial strength reduction factors are applied to the design strength of substrata and platform material properties;

- Ultimate Limit State (ULS) checks on bearing capacity and Serviceability Limit State (SLS) checks on immediate settlement need to be carried out;
- The method allows for multiple substrata layers, including potentially weaker layers at depth;
- Load spread in the platform and substrata is calculated using the Boussinesq theory;
- The maximum load spread in the platform is explicitly limited to 2V:1H;
- Lateral pressure (confinement) in the platform or upper substrata layers is considered; and
- The method relies on load spread only, without allowance for punching shear resistance.

3.4 First Principle Methods

Where large areas of working platform have been required for a project, the opportunity to save cost through reducing the thickness of a working platform has driven some platform designers to undertake deign from first principles or detailed finite element (FE) modelling of working platforms. Platforms designed using finite element modelling are generally designed by limiting deflections under the plant and equipment load to within certain criteria.

These methods of analysis should only be undertaken by a Designer who is experienced in geotechnical engineering and analysis. The designer should ensure that they use appropriate load factors in accordance with Eurocode 7.

It should be noted that FE assessments should not be undertaken in isolation, and it is advised that a first principles assessment is undertaken in conjunction with an FE assessment. Also, consideration should be given to the required input parameters for a potential FEM analysis. For example, undertaking a FE assessment based on a ground model derived from DCP data alone may not produce an accurate analysis.

3.5 Geosynthetic Supplier Provided Designs

Suppliers of geogrid will often provide a working platform detail based on their own in-house design methods. It is important to note that these details are generally provided as an “application suggestion” and not for construction design.

These details should not be used without first being verified by a competent designer who understands the supplier design methodology.

4.0 ASSESSMENT OF LOADS

4.1 General

It is the responsibility of the contractor (or subcontractor) controlling the operation of the plant to provide maximum ground pressure loading from the plant items to the TWC. In some cases there may be multiple subcontractors using a platform for different plant through the life of the platform. In these cases all anticipated plant uses should be collated and included in the temporary works brief by the TWC to allow the platform design to be optimised. Where this is not practical or changes in methodology result in a change to the plant or load conditions, then this information should be provided to the temporary works designer to analyse whether the designed platform is sufficient or whether platform modification or operational constraints are required.

The plant loading to be provided should consider all operating conditions (standing, handling, lifting, drilling, extracting, travelling and erection/dismantling) and in all orientations as they have an influence on the derived design actions.

Where possible, loading information should be obtained directly from the manufacturer or supplier of the equipment. The quality of the information that can be directly obtained may vary. In cases where this has not been directly obtained, the following should be checked:

- Applicability to the plant configuration to be used including any ancillary equipment;
- Whether any partial load factors or dynamic enhancement factors have been included;
- Assumptions on the use of stabilising components e.g. use of the mast foot on piling rigs;
- Whether wind loads have been considered (this is particularly important when considering lifting involving elements with a large surface area which could attract significant wind load and act as a sail).

Where the supplier/manufacturer is unable to directly provide such information, it may be necessary to evaluate these loads independently. These can be calculated using plant manufacturers' software and websites or through the use of bespoke calculation spreadsheets, such as the Rig Loading Spreadsheet developed by the Federation of Piling Specialists (FPS). Note that these approaches are very sensitive to the use of accurate and appropriate inputs and should only be carried out by suitably competent and experienced personnel.

4.2 Tracked Plant

For tracked machines, it is not appropriate to take the average bearing pressure either obtained from a plant datasheet or calculated from the gross weight of the machine distributed across the available bearing area. Even when at rest, a significantly uneven load distribution is common.

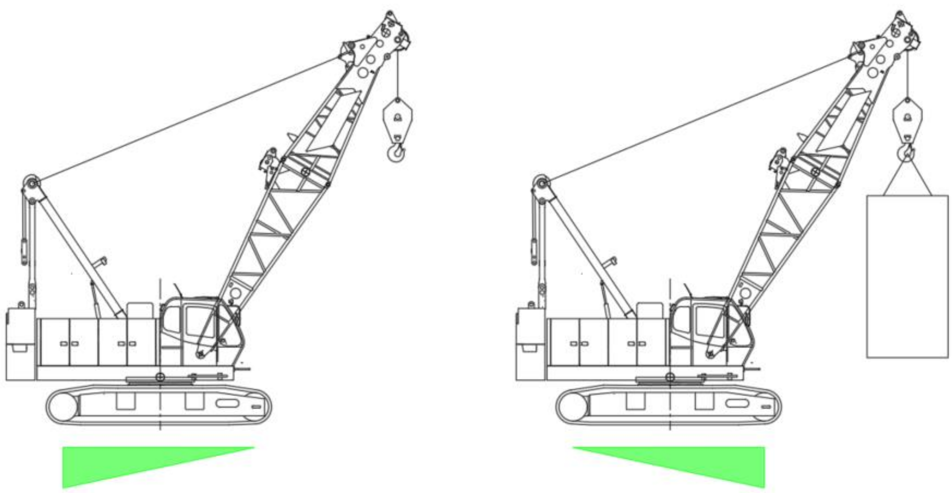

Figure 2: Representative bearing pressures under crawler cranes with and without load.

It should be noted that it is often not the largest rig or the heaviest lift which is most critical in the design. The influence of track dimensions should also be considered as this is directly related to the depth of influence for the design. The unloaded standing and travelling cases should be assessed as these may prove to be the critical load cases.

Both BRE470 and TWf2019:02 require loading to be modelled as rectangular uniformly distributed loads. Where load inputs are provided as trapezoidal or triangular distributions, they should be transformed using the method described by Meyerhof (Meyerhof 1953).

The distribution of loads also needs to consider the specific application. For instance, in the case of piling rigs, the stress distribution under the tracks can vary significantly depending on whether one is considering a pushing operation or a pulling operation or if the rig has a foot at the base of the mast which engages the ground. For cranes, lifting angles, load mass and radius dictate the maximum track pressure. In such cases, the most unfavourable slew angle should be considered, unless it can physically be excluded from happening or strict operational control and monitoring is in place.

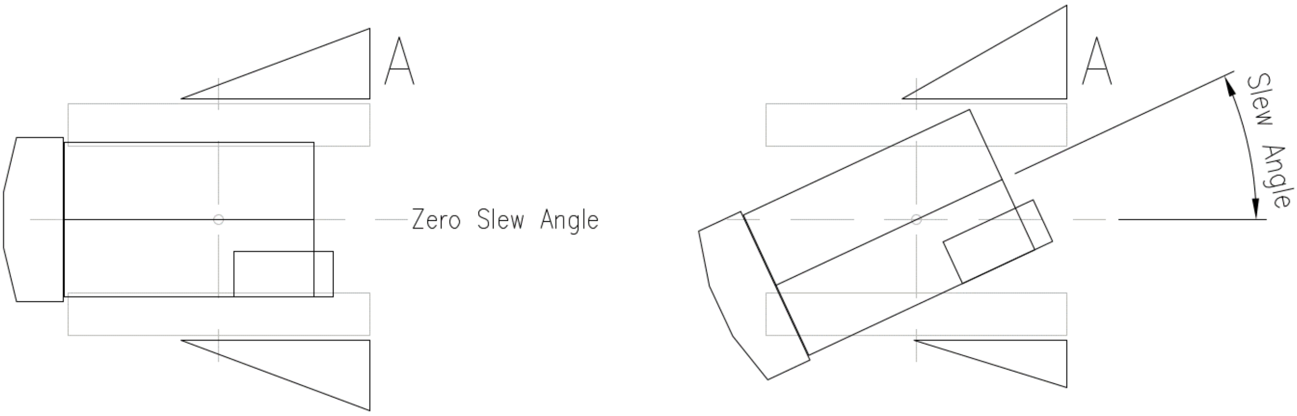

Figure 3: Showing differing pressure distributions based on swing angle of crane. The calculated peak track pressure (A) for the crane lifting with a swing angle is significantly higher.

4.3 Outrigger Loadings

Outrigger loads are generally more sensitive to deflections. Therefore, a suitable testing regime for both the subgrade as well as the granular platform fill are essential. If the method of assessment is based on the theory that the working platform itself is generally rigid and that therefore the critical design case is punching failure through to the subgrade, distribution of the loads through the working platform are generally ignored. Where a crane company provides rigid pads, such as hard timber mats (‘Swamp mats’) or steel plates to support outriggers, the reliable contact area should be checked when assessing the sub-grade.

Where pads have been checked to act as rigid elements, or where a granular working platform has been designed, loads can generally be distributed through the platforms such that the loads on the underlying sub-grade are less but applied over a greater area.

Where the calculations produce a non-economic thickness of granular fill, then the use of additional intermediate layers such as hard timber mats should be considered to further spread the load across the surface of the platform. In some cases, the use of a larger crane may reduce the pressure during the lift however it must be considered that the overall mass of the system remains the same.

4.4 Limits for simplified design methods

As mentioned in Section 4.3 above, the BRE method generally assumes that punching failure governs and hence may be considered conservative. In addition, care needs to be taken when only considering a force-based design approach which does not adequately account for settlement issues. It is often important to consider both where, for example the subgrade material is variable or where shallow services are present.

The TWf method is more in depth and while it undertakes the same steps for checking bearing capacity as the BRE method it also undertakes the following:

- Derives nominal effective area (and nominal load spread) using the maximum increase in vertical pressure beneath the centre of the load calculated using Bousinesq theory.
- Adopts a maximum load spread angle of 26.6 degrees (2H:1V) through the platform

- Assesses lateral pressure in the platform, granular subgrades and cohesive subgrades and hence the horizontal shear on the formation.

5.0 SUBGRADE AND GROUND CONDITIONS

5.1 Investigation methods and extent

Investigation methods will vary geographically depending on the nature of the natural sub-grades and characteristics of the site locality. It is therefore important that the Temporary Works Designer is familiar with the local geology and specifies appropriate test methods. Site accessibility may also limit the use of particular investigation methods.

Two of the most common methods of testing granular sub-grade formations in New Zealand are the Scala penetrometer and the plate loading test.

Cohesive soils can be tested with a handheld shear vane to give an indicative undrained shear strength for use in platform design calculations. Plate load testing can also be used to assess the strength of cohesive soils.

Intrusive investigations should be included as part of the investigation regime to accompany the testing above to allow classification of the soils for reliable geotechnical parameter selection.

It is the responsibility of the platform designer to assess the available geotechnical information. If further testing is required this will be up to the platform designer to specify. They will then interpret the results of any investigations and determine the platform design parameters.

5.2 Zone of influence

Careful assessment of the zone of influence (ZOI) must be considered with respect to both the imposed load from the plant and the imposed load from the surcharge of the material from which the working platform is constructed.

The ZOI of a platform is not only the function of increased stress on the sub-grade but also of the physical dimensions (plan area) of the platform. Estimates of the ZOI using the Boussinesq pressure bulbs or Fadum Chart can be used. This will help to inform the minimum depth of any investigation required for the design.

The ZOI of testing must also be appreciated. E.g., a 400 mm dia plate load test will have a much shallower ZOI than the track of the plant that will likely be using the platform. Testing should always extend at least 1m beyond the calculated ZOI to confirm the absence of any weaker layer at depth which may affect the overall settlement prediction. Generally, an investigation depth should extend to at least 3 times the width of the track of the proposed plant.

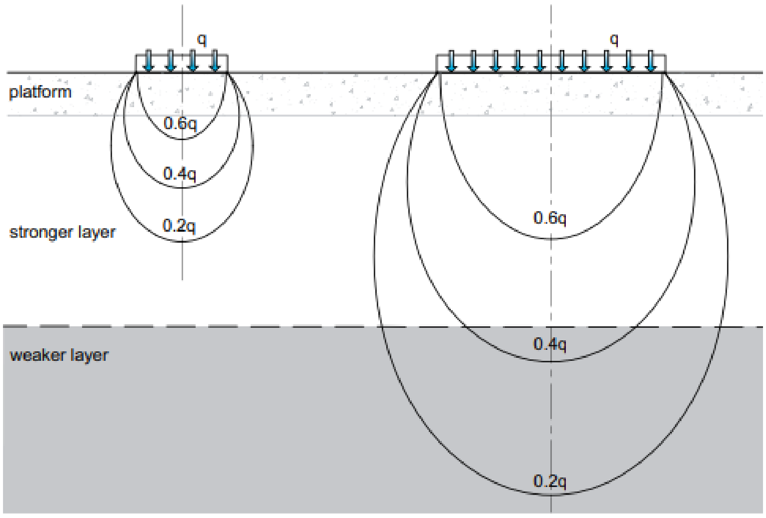

Figure 5: Boussineq pressure bulbs and associated zones of influence (TWF 2019:02)

Experience has shown that the lateral ZOI of a loading platform can extend beyond the platform itself by over 50% of the overall platform width. This becomes very important where thick structural platforms are required over weak ground.

The platform designer must also consider the effects of the working platform on any buried structures (such as tanks) or adjacent basements and whether the ZOI will interact with these.

5.3 Seasonal influences

In many areas throughout New Zealand, residual soils undergo large changes in strength and associated stiffness with varying seasons. This is an important factor in the selection of reliable design values for the subgrade. For instance, during prolonged dry periods, the upper 1-2m of the ground may display high in-situ shear strength values due to soils being either partially or fully unsaturated. These values are not to be confused with fully saturated undrained shear strength values. Where working platforms are expected for longer periods of time (in excess of one month) on cohesive soils, it is recommended that calculations for subgrade strength should be derived from moderately conservative, fully-saturated soil strength values based on the underlying geological units.

5.4 Global stability considerations

Where slopes are located close to a working platform, specific slope stability assessments should be undertaken. If the platform is less than 3H:1V from the toe of a slope, then a slope stability assessment will need to be undertaken. While these assessments may not require any calculations, per se, they should, as a minimum, consist of a physical assessment by a suitably experienced and competent geotechnical engineer or engineering geologist.

This can be of particular importance when streams, rivers or culverts are in close proximity to the working platform.

Depending on the intended design life and uses of the platform, some degradation in the strength of the underlying materials may need be considered. In addition, careful attention should be given to ensuring that the working platform design includes adequate drainage measures to account for high intensity rain fall events and anticipated flooding events.

5.5 Access tracks

In general access tracks should be designed to similar standards as working platforms but with lower load factors and will require less load cases to be considered.

If it intended for the track to be used by a fully rigged up piling rig then it will need to be designed to the same standard as a working platform with appropriate bearing pressures and load factors for travelling.

Where the track will be used by a crane then, if no lifting will occur, the track can be designed using unloaded track pressures. In this case, operational restrictions on slew and boom angles must be clearly communicated and controlled.

6.0 DESIGN OF THE WORKING PLATFORM

The design of temporary crane and piling platforms should be carried out with consideration of the influence of the platform on other structures or assets on the site or adjacent sites. These may include both, permanent works and/or other temporary works. These interfaces should be communicated in the temporary works design brief and checked throughout construction activities.

The platform may apply significant temporary loadings to these adjacent structures. However, these aspects of design are not covered in the above methods. Where this is the case, the relevant loading information should be provided to allow assessment of the adjacent structures. It is the responsibility of the TWC for the project to provide this information to the relevant permanent works designer/ temporary works designer/asset owner. Careful planning of different interfaces at the design stage is important for the mitigation of risk during construction.

The temporary works design brief should also identify any additional known hazards including, but not limited to:

- Buried services
- Backfilled trenches
- Local soft spots
- Wet piles or piles holes during construction
- Excavations
- Slope stability hazards.

The design methods used in BRE470 and TWf2019:02 both include partial factors to account for levels of uncertainty in the parameter selection (input) to the calculation and provide robustness to the method. The underlying assumption of these methods is that the platform is constructed using free draining, granular material.

The method described in BRE470 uses a bespoke variable load factor system, ranging from 1.05 to 2.0 (Table 2), which are applied to the characteristic load values applied by the construction plant. These load factors vary depending on whether the load case is deemed to be a recoverable or non-recoverable condition (Case 1 or Case 2). Higher load factors are applied in load cases where the operator is unlikely to be able to aid recovery from imminent platform failure.

- Case 1: Standing, Travelling or Handling – when the rig or crane operator is unlikely to be able to aid recovery from an imminent platform failure.
- Case 2: Drilling or extracting – when the rig or crane operator can control the load safely, for example by releasing the line load, or by reducing power, to aid recovery from an imminent platform failure.

The load factors also vary through the calculation process based on the stage of the design process. Typically, higher load factors are used initially to check whether the in-situ ground conditions can support the track loads without a designed working platform. Lower factors can be applied in ongoing design due to the greater confidence in material properties. No strength reduction factors are applied to geotechnical parameters, but a strength reduction factor of 2.0 is applied to geosynthetic reinforcement.

Table 2: ULS load factor values applied in BRE470

	Load Case 1 Non-recoverable	Load Case 2 Recoverable
Check whether subgrade can support plant without platform	2.0	1.5
Check that platform material can provide adequate bearing resistance	1.6	1.2
Calculation of platform thickness	1.6	1.2
Check of platform without reinforcement (where geosynthetic is included in design)	1.25	1.05

Due to this variability, there is no direct comparison between the load factors used in this process and combination factors given in AS/NZS 1170.0:2002 Structural Design Actions Part 0: General Principles (Standards Australia 2002).

The method described in TWf2019:02 allows the use of various partial factors throughout the calculations to apply different limit state approaches. Three different limit state combinations are discussed in TWf2019:02, CIRIA SP123 and the combination 1 and 2 in accordance with the UK Annex to EC7.

Table 3: ULS partial factors for use in TWf2019:02 including NZ derived load factors.

		EC7 comb 1	EC7 comb 2	SP123	AS/NZS1170.0 & B1/VM4
Permanent action	(γ_G)	1.35	1.00	1.00	1.20
Variable (imposed) action	(γ_Q)	1.50	1.30 (1.00*)	1.00	1.50
Cohesion	(γ_C)	1.00	1.40	1.25	1.00
Shear angle	(γ_ϕ)	1.00	1.25	1.25	1.00
Resistance	(γ_R)	1.00	1.00	N/A	1.67-2.22

*Recoverable drill rig load cases (Class 2, above) may be assessed with a partial load factor on variable actions of 1.00 in accordance with EC7 Clause 2.3.7.1(5) due to the recoverable nature of the load case limiting the consequences of failure.

Of the combinations above, only EC7 combination 1 can be directly compared to the ULS combination factors given in AS/NZ1170. It is noted that the use of EC7 combination 2 and CIRIA SP123 partial factors will tend to produce more conservative results, particularly for platforms on granular formations. This is due to the influence of the partial factor γ_φ which is applied to the shear angle of the soil and results in a significant reduction of the bearing capacity factor Nγ.

In the absence of robust research into the use of New Zealand partial factors in this method, caution is recommended where this approach is used. Results should be compared against the partial factor combinations proposed in TWf2019:02.

Some international standards provide wind loads for mobile cranes. For example: Australian Standard AS 1418.5 (Standards Australia 2013) stipulates a 10 m/s wind speed for in service conditions and 15 m/s for out of service conditions for mobile cranes. These can be considered to be applicable to piling rigs. Such loads need to be taken into consideration for the assessment of loads applied by plant and equipment and are usually not part of the scope of the working platform designer.

Dynamic load factors for the working platform design are not considered by either method and the applied track bearing pressures are assessed as static loads. Dynamic load factors are typically not considered in the design of working platforms and only static load cases are utilised.

Dynamic loads are typically addressed in the assessment of the load applied by the specific type of plant, not in the platform design. It is particularly important for piling plant to consider such dynamic effects, notably for plant with high centres of gravity, such as Continuous Flight Auger (CFA) rigs, where the drill motor is typically located close to the top of mast during the travelling mode. Dynamic loading can occur especially after sudden changes of direction (during travelling) or by moving down a grade. It is recommended that additional platform thickness is included at the base of access ramps to allow for this increased loading. BRE 470 suggests increasing the local platform thickness by 50% or including additional reinforcement.

7.0 PLATFORM CONSTRUCTION

7.1 Inspection and Test Plan

It is recommended that an Inspection and Test Plan (ITP) is established for the construction and maintenance of the working platform. Any inspection and tests that are deemed necessary to confirm the adequacy of the construction should also be stated by the platform designer in a drawing or design report.

As a minimum, the ITP should contain:

- Reference to the relevant platform design drawings or design report
- Subgrade inspection hold points and any testing requirements
- Any requirements or hold points for proof rolling and walkover inspections for soft spots
- Material specifications for fill and geosynthetics including any material testing/grading requirements.
- Method of fill placement including number of layers, minimum/maximum layer thicknesses, required compaction plant, and any layer compaction tests (including test frequencies).
- Dimensional tolerance checks, including minimum platform thicknesses and edge distances for the platform, lap lengths of geosynthetics.
- On-going regular maintenance check requirements.

7.2 Subgrade inspection

Ideally, subgrade inspections are undertaken by both the designer and constructor prior to placement of the working platform fill. The purpose of the subgrade inspection is to check that assumptions made during design are still relevant and that any ‘soft-spots’ are identified and remediated before construction of the platform begins. Any required subgrade testing should be noted in the design drawings or design report.

7.3 Platform and Subgrade Testing

Any subgrade or platform testing requirements that are deemed necessary to confirm the adequacy of either the subgrade or working platform should be provided in the design drawings or design report. Furthermore, the test type, frequency and acceptance criteria should be provided for all specified tests.

Tests that might typically be used are detailed in Section 8.

8.0 PLATFORM VERIFICTION AND CERTIFICATION

8.1 The Importance of Verification

The verification of working platforms is a critical step in the process. Certification should be completed before the platform is loaded with plant. Verification should be managed by the Temporary Works Coordinator (TWC). With high risk or complex platforms, it is recommended that this verification process is completed with or witnessed by the Designer.

The Designer should clearly specify inspection and test requirements necessary to confirm that the platform construction is suitable, sufficient and in accordance with the design. Testing requirements should have clearly defined acceptance criteria, testing frequency and applicable standards.

This may include verification of:

- Subgrade geotechnical parameters against design assumptions
- Groundwater levels
- Platform geotechnical parameters, compaction and thickness
- Platform deformation performance under test loading
- Other site specific parameters or identified risks

In addition to the verification methods specified by the designer, it is important that the verification process identifies any significant changes to the design. These should be clearly communicated to the Temporary Works Designer. Examples of changes which should be communicated include variation of the platform extents, identification of buried services, differing ground conditions or the use of alternative geotextiles.

8.2 Verification Methods

The below table gives some standard in situ test methods and where they are appropriate for use.

Table 4: Standard in situ test methods

Test Method	Application
Dynamic Cone Penetrometer / Scala	Strength testing for fine-grained cohesionless and cohesive soils
Hand Held Shear Vane	Strength testing for cohesive soils
Nuclear Density Meter	Compaction testing of granular material that has been laid as a working platform
Clegg Hammer	Compaction testing of granular material that has been laid as a working platform
Plate Load Testing	Strength/deformation testing of either subgrade or constructed working platform.
Testing using site plant (e.g. proof rolling)	Assessment of subgrade or constructed working platform deformation – to be used with caution under the guidance of an experienced engineer.
Lightweight Deflectometer	Potential for stiffness testing of granular backfill/constructed platforms **following completion of ongoing research.**

The above testing can be undertaken in accordance with various standards. It is important that the standard to which the testing was undertaken is noted on the logs/data.

As mentioned in section 5.2, it is important to appreciate the depth of soil investigated or verified with these methods and the limitations on some of this equipment. For example, a Clegg hammer will only give results over a ZOI of approximately 150 mm and will give unconservative readings when placed on large cobbles in granular fill.

Testing using site plant can take various forms from proof rolling to using rigged plant to load individual outriggers. The counterweight can be slewed over individual outriggers to apply the maximum load using the plant weight alone and the resulting deflections monitored. This form of verification should only be used under the guidance of an experienced engineer.

8.3 Documentation and Certification

Clear documentation of quality assurance is important for robust control of temporary works. A suitable platform certificate should be used to document the verification of the as-built platform, appended with the relevant QA. This certificate should be completed by the TWC or delegated representative.

An example of the TWf NZ/ FPS NZ platform certificate is provided in Appendix A.

Acceptable alternatives for platform certification include:

- FPS (UK) platform certificate https://www.fps.org.uk/content/uploads/2018/12/FPS-WPC4d-June-2015-updated-logo.pdf
- PFSF (Aus) platform certificate http://pilingfederation.org.au/wp-content/uploads/2017/09/Working-Platform-Certificate.pdf
- A Design Check Certificate available in the Appendices of TWf NZ GPG01:19 Temporary Works Procedural Control Good Practice Guideline https://www.engineeringnz.org/documents/864/Temporary_Works_Procedural_Control_GPG01-19.pdf
- A bespoke certificate which aligns with the requirements of those included above.

8.4 Reassessment and reverification

It is the responsibility of the TWC to engage the Temporary Works Designer if the platform requires reassessment or verification. The platform should be reassessed as required, including under the following circumstances:

- The design loading changes e.g. alternative plant is used on the platform
- The platform geometry changes e.g. the platform is extended or operational constraints on plant position are changed
- The ground conditions vary e.g. seasonal variation of groundwater level outside the original design range
- Platform performance is outside expected parameters e.g. excessive deformation is identified.

The responsibility for determining the circumstances in which a platform needs re-assessment should be agreed prior to starting the works.

Any modification from the original parameters/ specification should be subject to reverification. For minor modification, it may be appropriate to add an addendum to the existing Platform Certificate. Significant changes should be subject to a new Platform Certificate

9.0 PLATFORM MAINTENANCE

It is the responsibility of the TWC to ensure that the platform is maintained and repaired as required during its lifetime to ensure it meets the minimum design requirements.

Maintenance and repair requirements may include, but are not limited to, the following:

- Repair of any rutting as it develops during operation particularly where there are changes in grade of the platform and platform entrances/exits.
- Removal of any build-up of soil on the surface. Care should be taken to not to cut into the platform and reduce its thickness when removing soil.

- It is preferable to avoid cutting through the platform, but if this is unavoidable then it should be reinstated in a manner that maintains the intended platform performance.
- Soft spots created or identified during operation should be immediately removed and replaced with new compacted material.
- Low spots in the platform can cause water to build up and pond over time. Ideally the platform is maintained and graded in a way that allows surface water to drain off it.
- Bored piles should be filled up to the top of the platform or the void otherwise supported or backfilled and compacted with suitable platform material.
- Where geosynthetics are unintentionally cut through (except by piling or as permitted by the designer), the area of damage should be replaced and tied back into the existing layers considering manufacturers recommendations and minimum lap length requirements.
- Where the platform is traversing new or existing services – these should be subject to a separate check on both the structural capacity of the service and the geotechnical capacity of the platform. Timber mats, steel plates or a suitable bridging structure may be needed to ensure the services remain protected.

10.0 REFERENCES

1. Building Research Establishment (2004) *Working platforms for tracked plant: good practice guide to the design, installation, maintenance and repair of ground-supported working platforms,* BRE Bookshop, Watford.
2. Temporary Works Forum (2019) *Working Platforms – Design of granular working platforms for construction plant – A guide to good practice – TWf2019:02*, Temporary Works Forum, London.
3. Temporary Works Forum (NZ) (2019) *Temporary Works Procedural Control Good Practice Guideline.*
4. Health and Safety at Work Act 2015 https://www.legislation.govt.nz/act/public/2015/0070/latest/DLM5976660.html
5. Building Act 2004 https://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html
6. Building Regulations 1992 https://www.legislation.govt.nz/regulation/public/1992/0150/latest/DLM162576.html

APPENDIX A: WORKING PLATFORM CERTIFICATE EXAMPLE

TEMPORARY WORKING PLATFORM CERTIFICATE

1A. GENERAL DETAILS	
Project / Site:	
Location:	
Task:	
Ref No.:	
Revision:	
Geotechnical Report/Investigation details	

1B. PLANT DETAILS		
Plant type	**Operational limits**	**Notes**
Piling rig/Crane	Max lift/Max line pull etc	Outrigger/swamp mats etc

1C. TEMPORARY WORKING PLATFORM LOCATION AND LAYOUT
Plan Sketch
Sketch plan or refer to attached plan

2A. TEMPORARY WORKING PLATFORM DETAILS	
Sketch	
Sketch detail/cross section	
Subgrade assumptions:	
Subgrade testing requirements:	Test type, Frequency, Depth
Geotextile/Geogrid Details:	
Platform Material:	
Layer depth:	
Compaction requirements:	
Minimum edge distance requirements:	
Other:	Slopes/Erosion protection/specific inspection requirements

TEMPORARY WORKING PLATFORM CERTIFICATE

2B. SERVICES	
☐	Buried/underground services have not been identified in the area of the working platform.
The following services have been considered:	
Service	**Requirements**
450 mm dia RC stormwater	Tracking only

3. DESIGN CERTIFICATION		
Designer Name:		Signature:
Company:		
Qualifications:		
Phone No.:		
Email:		
Designer to Verify Platform Construction:	Yes/No (circle one)	
Designer Verification Requirements (if applicable):		

4. CHECK CERTIFICATION		
Checker Name:		Signature:
Company:		
Qualifications:		

5. PERMIT TO LOAD			
	Yes	No	NA
Have the Design and Design Check sections been completed			
Does the as built working platform conform to section 2			
- Is the subgrade consistent with design assumptions and has entire area been proof rolled and witnessed by a competent person?			
- **Where soft spot have been identified has remediation details been attached in a sketch**			
- Is the working platform thickness consistent with the design details?			
- Have geotextile and geogrid been installed as per the design details?			
- Does compaction testing show adequate compaction of the platform material?			
- Are the platform extents consistent with the layout drawings/sketch?			
- Have platform extents been marked on site?			
- Have services been identified and operational limits or requirements briefed to platform users?			
- Have operational controls been briefed to the platform users?			
- If required, has approval been obtained from the permanent works engineer?			
- Have all environmental controls been installed?			

The working platform detailed above has been installed to the design and tested as required to safely support the equipment detailed in the Design Certificate above.
The working platform will be regularly inspected, maintained, modified, repaired and reinstated to the as-designed condition after any excavation or damage, throughout the period when the platform is in use.
A completed copy of this signed certificate will be provided to each user of the working platform prior to commencement of any works on site including subcontractors.

TWC Name:		Signature:
Qualifications		
Phone No.:		
Email:		

TEMPORARY WORKING PLATFORM CERTIFICATE

6. MAINTENANCE REQUIREMENTS			
IF THERE ARE ANY CHANGES TO THE PLANNED USE OF THE WORKING PLATFORM THE DESIGNER MUST BE CONTACTED AND ADVISED OF THE PROPOSED CHANGE.			
Inspection frequency:	Minimum weekly for piling platforms and monthly for crane platforms as well as following extreme weather events.		
Updates to details			
Date	**Description**	**Designer Check**	**TWC Authorisation**

7. MAINTENANCE INSPECTION RECORD				
Date	**Person**	**Position and company**	**Signature**	**Comments** **(Incl: Date of next inspection, details of changes, details of maintenance, changes to planned use, communications with designer)**

GENERAL NOTES

Maintenance and repair requirements may include, but are not limited to, the following:

1. Repair of any rutting as it develops during operation.
2. Removal of any build-up of soil on the surface. Care should be taken to not cut into the platform and reduce its thickness when removing soil.
3. It is preferable to avoid cutting through the platform, but if this is unavoidable then it should be reinstated in a manner that maintains the platforms performance.
4. Soft spots created or identified during operation should be immediately removed and replaced with new compacted material.
5. Low spots in the platform can cause water to build up and pond over time. The platform should be maintained and graded in a way that allows surface water to drain off it.
6. Bored piles should be filled up to the top of the platform or the void otherwise supported or backfilled and compacted with suitable platform material.
7. Where geosynthetics are unintentionally cut through (except by piling or as permitted by the designer), the area of damage should be replaced and tied back into the existing layers considering manufacturers recommendations and minimum lap length requirements.