A REVIEW OF THE EFFC/DFI GUIDE TO WORKING PLATFORMS 2ND EDITION

Stephen Buttling, National Geotechnical Consultants, Brisbane, Australia,
stephen.buttling@ngconsult.com.au
David Corke, Northwich, UK, djcorke@outlook.com
Michael Dobie, Tensar, Jakarta, Indonesia, mike.dobie@cmc.com
Martin Larisch, Larisch Consulting, Waikanae, New Zealand, mdlarisch@gmail.com

ABSTRACT

The EFFC/DFI issued a Guide to Working Platforms in December 2019. Since December 2022, the authors, and many others, were involved in the preparation of a revised Edition, Ed2, of the Guide, which was published in May 2025. This states in its opening section that "*the guide outlines tools for a practical implementation of better practices that can be adopted across the world*." However, in the opinion of the authors it does not provide adequate practical advice across a number of very important areas. These include:

- The basic calculation of the bearing capacity of a strong granular layer over a weaker subgrade, such that new platform designers will have a better understanding of what the various available calculation methods are trying to achieve, and why there is not a simple mathematical formula.
- An understanding of the behaviour of high friction angle soils and materials, which have become the preferred choice for working platform materials because of the thinner platforms that are required.
- The statements that a Design Method needs to include at least three components, and maybe four, and that they must be compatible, but no advice is offered as to how this can be achieved.
- The use of calibration in a semi-empirical method, how this is carried out, and what limitations it creates on the use of the output.
- A number of questions with regard to the determination of tracked rig bearing pressure, which was not adequately addressed.
- The subject of testing, particularly to confirm the angle of friction of the platform material.
- The statements that "The working platform is temporary works and its design must be managed as such" yet no advice is offered as to what this means or how it is to be applied.
  The shortcomings in these key areas will be identified as a caution to readers and, where space permits, alternative practical advice will be provided.

Keywords: working platforms, design, bearing capacity

INTRODUCTION

This paper has been written with specific reference to the EFFC/DFI Guide to Working Platforms, Edition 2 (Guide 2) published in May 2025, with the preparation of which the authors were involved over a number of years. It is noted that all of those involved in the revisions have significant experience of at least one aspect of working platforms, and that there are also many publications available to which reference can be made. However, it is considered that, because of the inherent complexity of the subject matter, it is necessary to wind back and start at a level suitable for those who are new to this special application. This paper will try to point out where additional information is recommended and, within the space confines allowed, will provide as much of the suggested information as possible.

In Guide 2 there is a lack of basic understanding and guidance helpful to a designer, especially a new designer. An attempt is made here to provide concise, simple, practical explanations of the derivation and application of design methods in common use, to assist designers in selecting, understanding and utilizing their chosen design method appropriately.

 © Deep Foundations Institute 2026

BEARING CAPACITY OF HOMOGENEOUS SOILS

The design of working platforms is a two-layer problem, consisting of a strong upper layer (the platform) supported by a weaker subgrade. However, as part of the design process, assessment of the bearing capacity of a homogeneous layer is also required. The bearing capacity of surface or shallow foundations, even though governed by some widely accepted design methods, is a complex subject, so before getting involved in the details it is important to understand the fundamentals. The equation below was proposed by Terzaghi (1943) for the vertical bearing capacity of strip foundations (namely the two-dimensional case, such that the foundation has infinite length):

$$q = c'N_c + \gamma D N_q + 0.5\gamma B N_\gamma \quad [1]$$

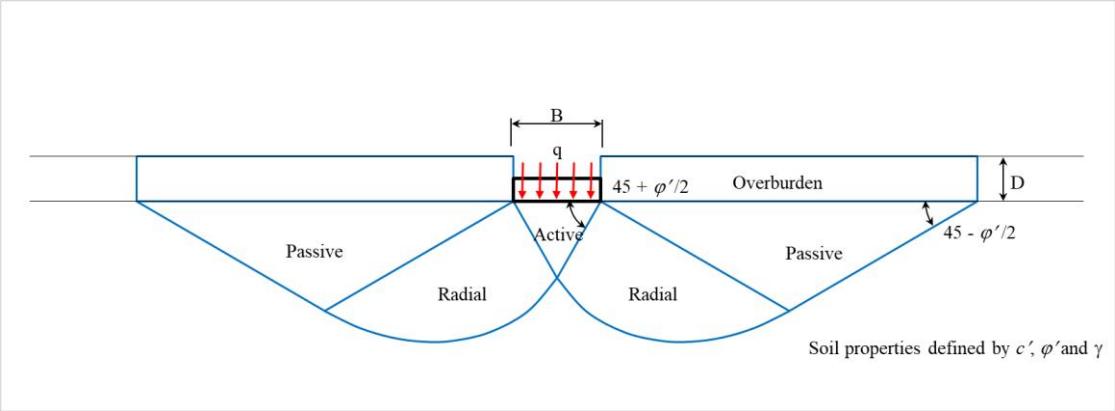


Fig. 1. Definitions for the general bearing capacity equation

As written, this solution is formulated in terms of effective stress, sometimes referred to as the drained condition. The three terms on the right-hand side predict the contributions from: the cohesion intercept of the soil; the weight of overburden above the foundation level; and the weight and frictional strength of the soil below the foundation level. All three terms may be adapted to different geometries and loading conditions by the application of factors. Shape factors (s_c, s_q *and* s_γ) are applied to take into account foundations of finite length, and inclination factors (i_c, i_q *and* i_γ) make allowance for resistance developed in directions other than vertical. The factors (N_c, N_q *and* N_γ) are referred to as the bearing capacity factors. In the cases of N_c *and* N_q closed form solutions for their values are well established as follows:

$$N_q = \frac{1+\sin\varphi'}{1-\sin\varphi'} e^{\pi \tan\varphi'} \text{ and } N_c = (N_q - 1)/tan\varphi' \quad [2, 3]$$

This leaves N_γ, but unfortunately the formulation is complex and a precise yet solvable equation to give its value over the full applicable range of φ' cannot be established. Various authors, including Meyerhof (1963), Brinch Hansen (1970) and Vesic (1973) (as used in BR470), have developed solutions, but these are all approximations. Martin (2005) used some advanced mathematics (the Method of Characteristics) to determine a precise value of N_γ for φ' values up to 50° in increments of 10°, and offered a tabulation of values up to 60° in increments of 1°, but these were discrete values with no given numerical relationship. Salgado (2008) proposed a simple equation that "fits (Martin's) values quite well", but it is still only an approximation, and Loukidis & Salgado (2009) found that, based on numerical analyses, previous approximations were too optimistic.

Relationship of N_γ to the Angle of Friction φ'

The bearing capacity equation is used in platform design to check the "platform only" resistance to applied surface loads. In this case the equation reduces to the third term only, including a shape factor:

 © Deep Foundations Institute 2026

$$q_u = 0.5\gamma B N_\gamma s_\gamma \quad [4]$$

The value of N_γ is related to the angle of friction (or shearing resistance) of the platform material, φ', which is the standard parameter used in calculating the shear strength of frictional materials in terms of effective stress, namely under drained conditions. In everyday geotechnical usage φ' will range from about 20° for clays up to about 38° for dense sandy soils. Most geotechnical engineers will be familiar with this range of soil types, and the corresponding bearing capacity factor, N_γ, has a reasonably consistent relationship with φ', as illustrated in Fig. 2.

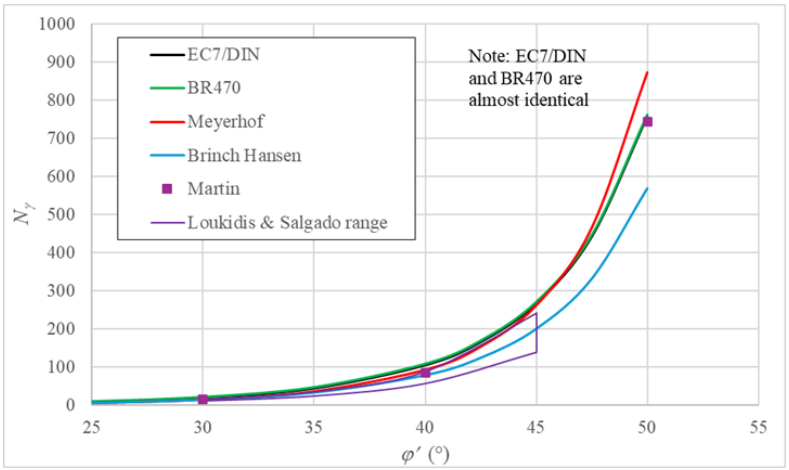


Fig. 2. Relationships between N_γ, and φ'

The problem is that, in order for working platforms over weak ground to be effective, they need to be strong, and that means that a high value of φ' is required, typically in the range of 40 to 50°. Looking again at Fig. 2, it is seen that the relationship of N_γ with φ' changes rapidly above 40° so that bearing capacity becomes more sensitive to the assumed, or measured, value. The reason for the sensitivity can be seen by comparing the slip-line fields, shown in Fig. 3, associated with the assessment of N_γ as shown in Fig. 2 for φ' values of 40°, 45° and 50°. Figure 3 also illustrates another point of which the platform designer should be aware, namely the extent of foundation soils required to generate the predicted capacities according to N_γ especially for high values of φ'. The width of the affected area more than doubles as φ' increases from 40 to 50°. This is important when considering the extent to which foundation material should have the required properties and be adequately compacted, as well as determining adequate distances between plant and the platform edge.

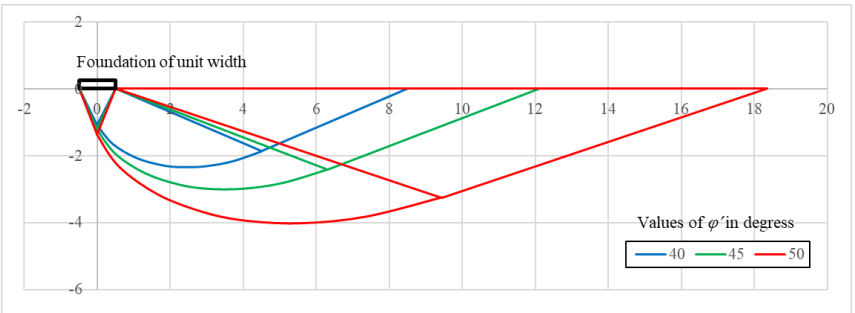


Fig. 3. Slip-line fields defined in the development of values for N_γ

Bearing Capacity for Undrained Conditions

Platform design methods also frequently require the assessment of the bearing capacity of cohesive soils under undrained conditions in which $\varphi_u = 0$, so that $N_q = 1$ *and* $N_\gamma = 0$, and the equation is simplified to:

 © Deep Foundations Institute 2026

$$q_u = s_u N_c s_c + \gamma D \quad [5]$$

It has been shown that $N_c = (2 + \pi)$ for undrained conditions and a strip foundation, and this has been found to match measured ultimate bearing capacity in practice. Shape factors (s_c) are also well defined for rectangular or circular foundations.

BEARING CAPACITY OF THE TWO-LAYER SYSTEM

When we move on to layered soils, as in a working platform over a weaker subgrade, the mathematics become even more complex, because the strength of the subgrade affects the strength of the platform. Some authors have tried to simplify the process, and sought for "an over-arching theory" (Miller, 2013), but this cannot be achieved. Where very complex mathematical equations can be reduced to something of the form $w = f(x.y.z)$, and substituting values for x, y and z gives you a value for w, we call that a "closed form solution", which can be explicitly solved. Unfortunately, sometimes the mathematics are just too complex, and there is no closed form solution. For example, we may have an integral for which there is no known answer. That is when we have to either accept a semi-empirical method, as with the bearing capacity equations, or use numerical analysis (e.g., finite element or finite difference), which makes extremely small increments to get as close as possible to the "answer", within a tolerance defined by the user. Both of these give us approximate answers, but do not provide an over-arching theory. Various approximations have been proposed for our layered soil bearing capacity problem, such as the methods of Hanna and Meyerhof (1980), T-Value (Lees, 2019), and Vrettos and Siebel (2023). While some authors have carried out numerical analyses that provide a solution for a given problem, that cannot be applied to other similar problems. Without a full understanding of these aspects, a platform designer may risk using methods that may not be applicable in certain situations, and this could lead to an overly conservative, or worse an unsafe, design. It is the authors' opinion that this risk is not identified in Guide 2 and, if used as is, increases the potential of this occurring.

The same is true of the parameter referred to as $K_p\tan\delta$, which is used in some working platform calculations. This creates the dilemma that we need these high angles of friction for economic working platform design, but the methods, and therefore the required platform thicknesses, are extremely sensitive to the values used. At the same time geotechnical engineers are likely to be unfamiliar with using and specifying values in this upper range, even to the extent that they may not be aware of the sensitivity. This includes the extent of the failure zone shown in Fig. 4. It has also been shown that, for example using the BR470 method, an increase of platform angle of friction from 45 to 50° can lead to a 30% reduction in the required platform thickness, with significant cost implications.

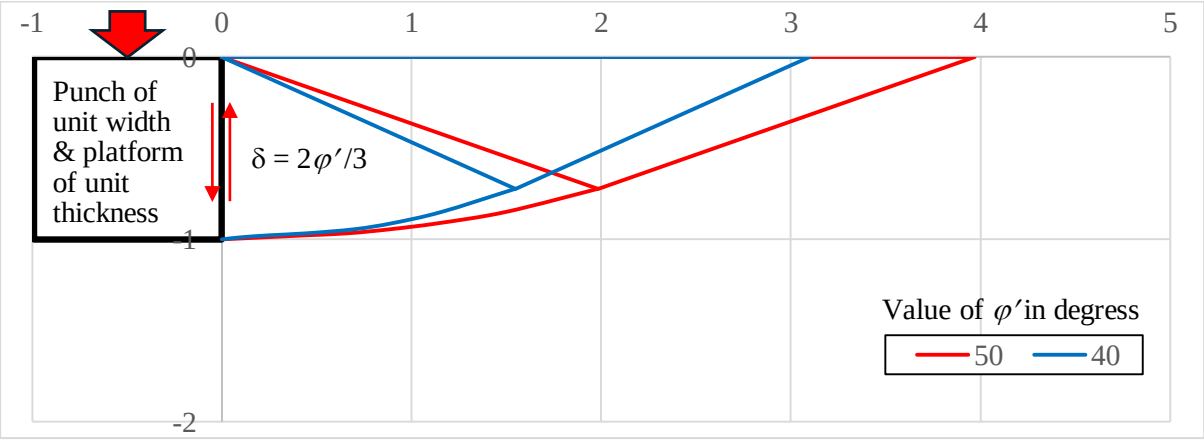


Fig. 4. Slip-line fields required to generate $K_p\tan\delta$ in punching shear methods

 © Deep Foundations Institute 2026

DESIGN METHODS

A number of methods have been developed over the years for the design of granular working platforms. They all function differently but share common components and characteristics. One of the issues, which is mentioned in Guide 2 but perhaps needs further explanation, relates to the definition of what constitutes a "Design Method". It is stated in Guide 2 that there are three essential components:

- rig track loading (input),
- the bearing capacity model, or calculation method; and
- the way in which safety is considered (factor of safety or reduction factors).
- To these could also be added:
- testing regime
- Each particular Design Method requires a prescribed combination of the necessary components.

It is important to distinguish between Design Methods, which are complete and lead to a Working Platform Design with a platform thickness, and Calculation Methods which are just one component and lead only to an estimate of ultimate bearing capacity. At the present time, in the authors' opinion there is only one complete Design Method, which is known as BR470 after the BRE Report (BRE, 2004), on which it is based. It is a semi-empirical method because the loading factors, published in the report and to be used in the method, were derived such that the method matched a set of benchmark working platform thicknesses. These were for the maximum bearing pressures and effective track lengths of seven selected rigs, on subgrades of strength ranging from the lowest the method could handle up to the highest above which a working platform was considered unnecessary. These were also for Working Platform angles of friction from 35 to 50°. This Design Method therefore has (i) the FPS Rig Track Pressure Calculation Tool V3.1 for its bearing pressure input, (ii) a calculation method using $K_p \tan\delta$ for ultimate bearing capacity, and (iii) loading factors as its approach to safety. This has since been supported by over 20 years of successful application in the UK, Australia and New Zealand. It is very important to note, with regard to what was stated earlier about understanding the process, that BR470 states clearly that "The design of working platforms for tracked plant is a geotechnical design process and should be carried out by a competent person."

There have been numerous suggestions since 2004 that BR470 is "over conservative", but the authors have come across no evidence to substantiate this. Corke and Gannon (2010) showed clearly that "conservative" platform thicknesses usually resulted from conservative estimates of subgrade or platform strength. In a specific case in Australia, subgrade parameters of φ' 32° and γ = 18kN/m^3 were proposed. The designer stated that BR470, which required a platform thickness of 970 mm for φ' = 40°, was known to be over conservative and proposed a platform of only 300 mm, which could potentially have been very dangerous. A subsequent enquiry drew the response that "970 mm was obviously conservative for medium dense sand", without noting that such a sand would not be characterized by φ' = 32° and γ = 18 kN/m^3. A rerun of BR470 with φ' = 36° and γ = 20 kN/m3 also gave a thickness of 300 mm. A published comment that "Typically the (BR470) method provides a working platform much thicker than commonly used successfully in Australian practice" has been clarified to refer to opinions expressed by main contactors, again without any supporting evidence.

While not a complete Design Method, the next method discussed is in the TWf Working Platforms: Design and construction of granular working platforms for construction plant (TWf, 2024) hereafter referred to as the TWf Guide. Its method, which uses Limit State Design principles, in accordance with Eurocode 7 (EC7, 2024), and partial factors on actions and strength based on that code. EC7 also states that "If needed, a modification of the results from the model may be used to ensure that the design calculation is either accurate or errs on the side of safety," which establishes a Model Factor. It goes on to say "If the modification of the results makes use of a model factor, it should take account of the following:

- the range of uncertainty in the results of the method of analysis;
- any systematic errors known to be associated with the method of analysis."

The authors are not aware of any work performed to establish that the method of calculation set out in the TWf Guide is either "accurate or errs on the side of safety." This would seem to require some sort of calibration, leading to a proposed model factor, which might be unity.

The BRE 470 Method and the TWf Guide Method are the only two methods listed in Appendix C of Guide 2, and it needs to be clearly understood that all the other references are to Calculation Methods. They do not generally have a bearing pressure method linked to them, nor do they have a safety approach. It is not possible to determine a safety approach without a rigorous calibration and verification procedure.

In Guide 2 a comparison has been provided, both in the guide and in the supporting reports, between up to 10 different calculation methods, based on the required platform thicknesses. This has used a standard track bearing pressure, effective length and width, together with a single value of angle of friction and weight density. Since only BR470 has a specified safety approach, the comparison has been made without any calibration or factors, which renders it meaningless.

Empirical Methods

Since there are no closed form solutions to the bearing capacity equations, all design methods are semi-empirical processes, which means that some constants in an equation have been chosen to obtain a fit to a set of data (for example the loading factors in BR470). This creates a severe limitation on the application of any such method, since it can only be used within the range of the data from which the constants were derived, and in the manner proposed and tested by the authors. Components of a semi-empirical method, such as partial factors, cannot be taken out and used in another method, as some practitioners have tried to do. Since a semi-empirical method has been calibrated, it is also not permissible to try to "improve" on the method, without going through an equivalent calibration procedure again. Miller (2013) and Miller (2020) are examples of where a modification of the BR470 method is proposed without repeating the calibration process.

Safety

BR470 established two Load Cases: Load Case 1, in which the Operator is unlikely to be able to aid recovery (such as standing, travelling and handling), and Load Case 2, in which the Operator can control the load safely, probably by reducing power such as (installing casing, drilling, extracting an auger, etc.). It then determined loading factors of 1.6 for Load Case 1 and 1.2 for Load Case 2, and how this was done will be described in the next section. It needs to also be understood that for Load Case 1 the requirement is to prevent failure in the platform and subgrade, whereas for Load Case 2 it is only to avoid failure for long enough for the plant operator to take the necessary action to prevent failure.

The TWf Guide recommends the application of partial factors in accordance with Eurocode 7, but an appropriate Model Factor has not been established, which does not meet the recommendations of EC7 as stated above. This is another example of why the TWf method cannot be considered a Design Method at this time.

CALIBRATION

BR470 Calibration

BRE produced a bearing capacity model based on the punching shear approximation as proposed by Hanna and Meyerhof (1980). Built into the Design Method are loading factors applied to the maximum predicted bearing pressures so, in order to enable the calculations to be used for working platform design, it was necessary to determine appropriate values for these factors. To assist with this requirement the FPS assembled a group experienced with the use of piling rigs and working platforms. Using the FPS rig track loading spreadsheet as input, the group considered rig operations of Standing, Travelling, Handling, Extraction and Penetrating.

 © Deep Foundations Institute 2026

In order to develop the loading factors, the FPS group calculated the rig track loading for a set of piling rigs, ranging from a mini-piling rig through medium size CFA (augercast) and rotary rigs to a large rotary piling rig. This data set, totalling over 500 scenarios for both cohesive and granular subgrades, was used by BRE to calculate required platform thicknesses using "other design methods" for subgrade strengths from 20 to 100 kPa and angles of friction from 35° to 50° for the granular working platform material. These platform thicknesses were then tabulated, reviewed and modified by the FPS team based on its collective experience, and became the benchmark of platform thicknesses that were considered safe, but still economic, and therefore should be produced by any design method. The loading factors for Case 1 and Case 2 were then adjusted over a number of cycles until it was considered that the numbers produced by BR470 matched the tabulated values, and therefore they were suitable to be used with the method. It was noted that a platform friction angle of 35° was inadequate for a number of rigs, and also noted that high friction angles have various issues as mentioned earlier. Therefore, it was decided by the FPS to limit the input angle of friction for the platform material to a maximum of 50°.

It must be understood that, while a calculation method such as the punching shear model, or the input data such as the rig bearing pressure from the FPS Spreadsheet, may of themselves be either conservative or non-conservative, any such effect is removed by the calibration process. The benchmark table of platform thicknesses was considered by the FPS panel of experts to be about right, and the loading factors were adjusted, using the ultimate bearing capacity from punching shear and the track pressures from the FPS spreadsheet, so that the required platform thicknesses were obtained, and this has been verified by the authors.

Thus, while the FPS method of calculating rig track pressures is approximate, involving several simplifications, any adverse effect of this has been removed. Therefore, it would not be acceptable, and potentially unsafe, to attempt to use track bearing pressures calculated on an alternative basis, such as the Austrian method or the EFFC/DFI simplified method referred to in Guide 2, in conjunction with the BRE design method and loading factors, or to use the FPS track bearing pressures with another design method without appropriate calibration.

Temporary Works Forum Method

TWf issued a Guide to working platforms in 2019 with an updated version published in 2024. The design method uses FPS loading for input with EC7 partial factors, but it is not known what calibration process may have been carried out to justify the calculated platform thicknesses. This is necessary because the solution to the bearing capacity equation used is approximate, and a model factor is required to account for any inaccuracies in the approximation, even if its value is unity.

RIG TRACK LOADING

Federation of Piling Specialists (FPS)

The rig track loading calculated using the FPS track loading spreadsheet was designed to be used with available information, notably the rig components and dimensions, winch/cylinder forces and suspended equipment. Wind and dynamic loading, as considered in more detailed calculations by rig manufacturers, in accordance with EN16228, are not included. Winch/cylinder forces can be adjusted to reflect requirements for a particular project for the most economic platform design. The spreadsheet calculates the variable bearing pressures along the length of a track, and then determines the Meyerhof equivalent rectangular distribution and effective track length.

It should be noted that the FPS loading is based on the rig operating on level ground, so it is important to consider the possible greater track pressures that may occur when travelling up or down a sloping ramp. BR470 warns that "*Sloping sites present particular problems for stability, which should be addressed in the design."* It is recommended that platform designers refer to manufacturers' instructions for appropriate gradients for ramps.

One aspect often overlooked is the potential risk of a rig overturning without any platform bearing capacity failure. The FPS spreadsheet calculates values for a parameter "Eccentricity Index". The spreadsheet does not provide limiting values, but Corke (2016) sets out guidance.

The disclaimer on the first page of the spreadsheet states that "the spreadsheet is intended for use only by a competent person". It has been reported that some users find the spreadsheet difficult, which has led to attempts to produce something simpler, such as the "Simplified EFFC-DFI method", the "STOPP – Machine Tipping Over", and the Austrian FSV (2002) "Platforms for Geotechnical Works RVS 08.21.02". These simplified methods have a place, such as at a preliminary stage when actual plant has not yet been selected, and provided they are adequately conservative.

The data was produced by a number of piling rig manufacturers, based on machine operating weight (including suspended equipment) on the basis of the rig working solely in extraction mode with the rig body in alignment with the rig tracks. Consequently, both tracks carry an equal load, which is the basis of the analyses in Appendix B. It has not been possible to check if the input data used by the rig manufacturers in producing this data were compatible with the FPS process. It is not possible to derive the numbers in the green columns in the tables from the numbers given in the blue columns, and thus the table cannot be verified. It is noted that various qualifications on the use of the table are provided, but it is questionable as to whether or not the advantages outweigh the risks associated with misuse.

The authors' experience over more than 15 years is that the biggest difficulty in the use of the FPS Spreadsheet is in obtaining the weight and centre of gravity of each component from the manufacturers. Guide 2 notes that piling rigs may include equipment, such as Kelly bars, drilling buckets, and augers, from other suppliers, and this is acknowledged. It has also been found that for a manufacturer to supply a consultant with the required details can be a breach of confidentiality. The simplest solution would appear to be for manufacturers to supply a catalogue with each rig, showing the weight and centre of gravity for each of their components. The manufacturers liability would then be only the accuracy of that data. It would be up to the piling contractor to identify which components they use, and to obtain similar data from any third-party suppliers. Although a certain amount of effort would be required in preparation of the catalogue, it would only be required once for each model, and this would significantly simplify the process. Since the catalogue would not indicate which components are fitted to any particular rig, it could also be issued to interested parties without breach of privacy restrictions.

Summary

With regard to rig track loading, use may be made of the UK Federation of Piling Specialists (FPS) Rig Track Pressure Calculation Tool Version 3.1. This was specifically prepared by the FPS for use with BR470, but has been adopted by the TWf Guide and may be applied to other methods subject to calibration.

The Guide 2 Appendix B track loading tables lack practical relevant data, do not represent critical design loading, are unreliable and are not considered to be appropriate for guidance or any other purpose.

TESTING

Testing, with regard to working platforms, is fraught with difficulties. It is reasonably obvious that the first requirement is to test any proposed material, but the particle size means that standard shear boxes used for Direct Shear tests cannot be used, unless the coarser particles are first removed, which calls into question the value of the test. Larger shear boxes, 300 mm square, have been used but are of limited availability. A Giant Shear Box, 1.5 m square, has also been used in the UK, but the results are

very limited. Several tests have been carried out with very large triaxial tests, 0.5 m diameter and 1 m high, which give very good results but are too expensive for routine use.

Once the material has been compacted into the platform there is an opportunity to carry out a test to confirm that the design requirements have been met, which usually means a specified angle of friction, φ'. Again, the question arises as to what test to use, because none of the available tests measure φ' directly, and rely on correlations.

The EFFC-DFI members put considerable time and effort into field trials of four in situ test methods, being Plate Load Tests (PLT), Light Weight Deflectometer (LWD) tests, and two types of dynamic cone penetrometer. One intention was to check on the simplicity of operating each test, which was reported and reviewed by the University of Stuttgart. Another intention should have been to review the correlations of the results with useful parameters but, although the correlations were published, no attempt was made to apply them, and hence to examine their variability and usefulness. It is considered that such a review would be of benefit to the piling industry, and should be included in the next edition.

Plate Load Testing

A programme of platform testing on 15 sites carried out in the UK since 2021 has shown that working platforms are more variable than it had previously been possible to quantify. The frequency of testing recommended by the TWf Guide will not be adequate to provide reliable data representing a whole site, requiring a conservative assessment of any such limited testing.

When BR470 was being developed there was considerable debate regarding the appropriate size of the plate. There was also the question of appropriate maximum test loading. The design loading (track bearing pressure multiplied by the appropriate loading factor) given by the BR470 design method was used by some as a maximum test load.

Due to the size and geometry of the loaded area of rig tracks it is not possible to carry out a single test that will prove the overall adequacy of a constructed working platform. The placed and compacted in situ platform material and the underlying subgrade need to be tested separately and independently.

If the size of the plate to be used can be minimised, the maximum possible test settlement can be achieved with the available kentledge, thus improving the reliability of the assessment of the test result. As it is commonly specified that material for working platform construction should have a maximum particle size of 75 mm, a test plate of 300 mm diameter would be advantageous. A medium size excavator that can safely provide a maximum test load of 10 tonnes is commonly used to produce the test reaction. This load equates to a maximum test pressure of approximately 1,400 kN/m^2, but even this typically results in a maximum test settlement of only a few millimetres.

Future Testing

The problem with plate load testing is that it is slow, expensive and ties up a piece of plant required to provide reaction, with typically only up to around six tests per day being achievable, which is likely why the test is not often performed. In order to address this problem, a programme of testing comparing plate load tests with Light Weight Deflectometer (LWD) testing in the UK was started in 2021 and is still under way. A LWD is a small, hand portable, device that drops a weight onto a 300 mm diameter plate (the same size as recommended for plate load testing). The output reports a surface dynamic modulus value and 60 to 80 tests can be performed in a day.

The initial objective was to see if a site specific correlation could be developed between the plate load testing and the dynamic modulus from LWD testing. A set of six plate load tests, each surrounded by four LWD tests was performed on each site in an area of 10 m x 5 m. Testing of the first few sites

shows that there was much variability, even within the test area, such that a correlation would not be achievable. Since then, testing on more sites has produced a wide range of data and a methodology is being developed that could provide a universal, rather than site specific, solution based on the use of the lower bound of the more numerous LWD dynamic modulus values. This approach is similar to the LWD requirements for road pavement sub-base testing in the UK.

TEMPORARY WORKS

This is a very wide subject, which can only be touched upon here. There seems to be a widespread belief that lower Factors of Safety apply to Temporary Works, but this surely should be restricted to situations in which the temporal variation of important parameters is taken into account. An obvious example is groundwater levels with regard to slope stability. With Temporary Works being of limited duration, the risk of an extreme event occurring during that short time is obviously reduced. However, when there are no temporal variables considered, such as when we are only concerned with the spatial variability of strength parameters, there is no logical reason for reducing the Factor of Safety, especially when there is significant risk to life, as when a piling rig topples over. Each case should be judged on its merits, as with the Load Case 1 and Load Case 2 selection.

OTHER IMPORTANT DESIGN CONSIDERATIONS

Apart from the matters dealt with above, which all relate to the components of any current or future Design Method, there are other general considerations which must be taken into account. These include, among other things, checks on global stability. This is always required as it is not checked by normal Design Methods, and is particularly relevant where working platforms are relatively small and edge effects come into play. Checking of these may lead to a requirement to cordon off certain areas as Plant Exclusion Zones.

The location of the groundwater table is extremely important for granular subgrades, and specific allowance is made for this in BR470. Where other methods are introduced, an equivalent allowance needs to be made.

Another consideration mentioned briefly under track bearing pressures is ramps. Once the revised pressures due to the inclination have been established, appropriate design needs to follow.

CONCLUSIONS

In order to understand the design of working platforms, it is first necessary to understand bearing capacity theory. The solutions to this are very complex and so require various approximations. It is therefore also necessary to have a grasp of the effect of these approximations, and how they can be minimised by calibration.

The high friction angle materials that are the first choice for working platforms because they lead to reduced thicknesses are very sensitive to the actual friction angle selected, which has a major effect on the definition of the failure surface. Their performance, testing and specification need to be well understood, and sensitivity analyses need to be carried out.

All working platform Design Methods each have a set of prescribed components which cannot be changed by the user.

Because they are based on approximate solutions, all Design Methods need to be calibrated against an accepted benchmark. The only ones currently available were prepared by the FPS in 2004, and subsequent revisions in 2009.

There are various options for the estimation of tracked rig bearing pressure, but one needs to be selected and built into the calibration of any Design Method.

 © Deep Foundations Institute 2026

Work is needed on testing to establish methods suitable for the high friction angle material required, both prior to use and when compacted into a platform.

Significant revisions to Guide 2 are required, and work should start on Guide 3 without delay.

ACKNOWLEDGEMENTS

The contribution of Scott Jacobs of Keller North America in reviewing the manuscript and providing invaluable comments is gratefully acknowledged.

NOTATION

B	Breadth of footing (track)
c'	Apparent cohesion
D	Depth of footing
q	Applied bearing pressure
q_u	Ultimate bearing pressure
q_0	Surcharge pressure
s_u	Undrained shear strength
γ	Weight density
φ'	Effective angle of friction
N_c	Bearing capacity factor on cohesion
N_q	Bearing capacity factor on depth of embedment
N_γ	Bearing capacity factor on breadth
s_c	Shape factor on cohesion
s_q	Shape factor on depth of embedment
s_γ	Shape factor on breadth
i_c	Inclination factor on cohesion
i_q	Inclination factor on depth of embedment
i_γ	Inclination factor on breadth

REFERENCES

Brinch Hansen, J. (1970) *A revised and extended formula for bearing capacity*. Danish Geotechnical Institute, Bulletin No 28, Lyngby

Corke D.J. (2016). A review of stability factor and eccentricity index for piling rigs. *Ground Engineering* December pp 23-25.

Corke, D.J. and Gannon, J. (2020). Economic design of working platforms. *Ground Engineering*, February 29-31.

Deutschen Bauindustrie e.V. (2019) STOPP - Machine turning over

EC7 (2024) *Eurocode 7: Geotechnical Design - Part 1: General rules*. BS EN 1997-1:2024

Eurocode EN 16228-4,-5:2014. *Drilling and foundation equipment — Safety, Part 4: Foundation equipment, Part 5: Diaphragm walling equipment*.

Federation of Piling Specialists. FPS Rig Track Pressure Calculation Tool V3.1 and Guidelines. fps.org.uk

FSV (2018) Platforms for Geotechnical Works. *Austrian Research Association for Roads, Railways and Transport (FSV)*; RVS 08.21.02 Edition 1, Wien.

Hanna, A.M. and Meyerhof, G.G. (1980) Design charts for ultimate bearing capacity of foundations on sand overlying soft clay. *Canadian Geotechnical Journal*, **17**, 2, 300-303

Lees, A (2019) The bearing capacity of a granular layer on clay. *Proc ICE Geotechnical Engineering*, **173**, 1, 13-20

Loukidis, D and Salgado, R (2009) Bearing capacity of strip and circular footings in sand using finite elements. *Computers and Geotechnics*, **36**, 871-879

 © Deep Foundations Institute 2026

Martin, C.M. (2005) Exact bearing capacity calculations using the method of characteristics. *In Barla, G., Barla, M. editors. Proc 11th IACMAG,* Turin, **4**, 441-450
Meyerhof, G.G. (1963) Some recent research on bearing capacity of foundations. *Canadian Geotechnical Journal*, **1**, 1, 16-26
Miller, K. (2013) *Technical note on use of BR470 in soft clay*. FPS
Miller, K. (2020) A review of Working Platform Design. *Proc Piling 2020 Conference*, ICE, London
Salgado, R (2008) *The engineering of foundations*. McGraw-Hill
Terzaghi, K (1943) *Theoretical soil mechanics*. New York, Wiley
Temporary Works Forum 2024. WORKING PLATFORMS: Design of granular working platforms for construction plant - A guide to good practice.
Vesic, A.S. (1973) Analysis of ultimate loads of shallow foundations. *Journal of the Soil Mech Div ASCE,* **99**, SM1, 45-73
Vrettos, h,C, and Seibel, E (2023) Punching shear of footings on a sand layer over clay: Calculation methods and findings from numerical parameter studies. *Geotechnik*, **46**

 © Deep Foundations Institute 2026