OCTOBER 21, 2021

DFI / EFFC - PROJECT FUND PROPOSAL
WORKING PLATFORMS - FIELD RESEARCH STUDY (FRS)

PRINCIPLE INVESTIGATORS: Peter Faust, Malcolm [pfaust@malcolmdrilling.com]
Jim DeWaele, Keller [jim.dewaele@keller.com]

1.0 INTRODUCTION

Safety is of outmost importance for everybody working in the construction industry. Deep foundation work typically involves the use of large and heavy equipment. The equipment is sometimes working on temporary steel platforms (trestles) but for most of the times is placed directly on the natural ground surface.

Since work is performed year around and in all weather conditions, the ground will experience a variety of weather-related impact from frost and thaw cycles to heavy downpours or drying periods. Frequent movement of the (mostly) tracked equipment will further degrade the work area and may lead to unstable (therefore unsafe) ground surfaces. This does require the installation of a stable, dry, and level work platform, which can sustain all these repeated impacts.

If such platforms are not adequately designed, constructed, and maintained, the used equipment may fall over and cause harm to adjacent property, personnel working on site or anybody of the public outside the project site.

In addition to the physical consequences, a machine toppling will certainly have a financial impact, it may lead to a delay to the project, have reputational ramifications and lead to civil claims or even criminal prosecution. A major cause of machine instability is a poor working platform or the unknown local cavities or soft spots as well as insufficient re-compaction of previous excavations. This may be due to a lack of design, poor quality installation, or a lack of maintenance or inspection. Given the consequences of a machine falling over, most would agree that each of these aspects should be carried out thoroughly and by competent people, yet on many sites, in many countries, this is still not done.

2.0 LITERATURE REVIEW AND STATE OF PRACTICE

Various publications in the world have highlighted the importance of safe work platform and provide guidance on how to design them, how to define the loading conditions and highlighted the difficulties on how to enforce the use of good and safe construction practice in the different parts of the world. But current practice does (almost never) provide any recommendation by the engineer to the owner or prime contractor for any platform design or construction.

We learned from historic data that most serious accidents with toppling machines happen after localized excavations (to relocated or remove utilities) were not backfilled appropriately. The lack of applicable standards and specification might be one reason, but most the times, the lack of testing methods which can be employed quickly enough is the simple reason.

In addition, most platforms today are designed by one party (if), constructed by a second party, and used by a third party. The third party is mostly the specialty subcontractor, who did not witness the construction and/or testing of the platform. Platforms may also change their requirements during usage, which should require additional investigation post construction. The addition of crane mats to overcome these challenges is certainly a good idea, but very often not cost effective. And those who have already used double (or even triple) layer crane mats, when the subsurface is very weak, would wish nothing more than better tools to ensure a safe work environment.

The Industry-Wide Working Group on Working Platforms has published a document (https://www.adsc-iafd.com/wp-content/uploads/2021/01/Working-Platforms-Document-1.pdf), which intends to raise awareness of the topic and serves as suggested framework by which allocation of responsibility can be communicated and determined long before work is performed on the jobsite.

The European Federation of Foundation Contractors (EFFC) and DFI have published a Guide for Working Platforms (http://www.dfi.org/viewpub.asp?tid=TM-PLATFORMS), where most of the available international publications are summarized. The guide also identified areas where knowledge is limited and where further research is required.

In addition to joint international efforts, a multitude of regional specifications and documents were developed over the last decade, such as by the Federation of Piling Specialists (PFSF), an independent working group out of the UK. The PFSF developed a "working platform certificate" (http://pilingfederation.org.au/wp-content/uploads/2017/09/Working-Platform-Certificate.pdf), which requires general information on the equipment to be used, the installation procedure and the contractor information, but fails to include any type of post installation quality assurance, maintenance recommendation, and continued integrity testing until project completion. While the contractor is required to physically sign to be responsible for all of the above, he/she is left with very limited universal guidance that will allow for scientific rigor in assessing site conditions and hold up during potential legal implications.

3.0 CHALLENGES AND PROJECT OBJECTIVES

The EFFC-DFI working group in their last meeting has identified **Testing and Verification** of working platforms as the area with the most urgent need for further research.

While plenty methods for subsurface investigation are available in the industry, none has yest been deemed suitable to test work platforms and verify their capacity **after** they are constructed. There is rarely enough time to perform an intensive testing program with CPT or SPT probing after the platform is constructed since work is typically scheduled to commence right away.

Proof rolling is one of the oldest means to check platform conditions, but results are very difficult to quantify. Most impact related hand-held devices (CBR, Dynamic Deflectometers, Nuclear Gauges) are designed for roadway surfaces and do not investigate deep enough. The plate load test using the standard 300mm plate does not 'look' deep enough for our typical track width and 762mm plate load tests require larger counterweights, which are not always available before the equipment is mobilized.

Available industry standards refer to roadway construction and general backfill requirements and are mostly based on proctor test results or nuclear density measurements for thin layers of backfill. Plate load test are sometimes required as verification tool but a correlation of measured deformation modulus to actual platform capacity have not yet been established.

We therefore believe that it would benefit the (not only) deep foundation industry, when better investigation tools and methods are available to quantify the stability or even assign the ultimate bearing capacity of a given working platform in the field and under various conditions the platform will experience throughout its usage.

This research aims to find a simple and quick to employ testing method, which can be used by qualified field personnel to verify the platform capacity in-situ. It is believed that such basic field tools, which could be carried by any work truck, would dramatically improve the safety of future work platforms. Rather to rely on our field personnel's experience to walk the site and 'see' how stable the ground it, they could verify its capacity with a simple (hopefully) hand-held unit within minutes.

Such field verification shall not only verify design assumptions for the platform itself, but may also be used to verify previous subsoil investigations results for the layers below the working platform to sufficient depth based on the track loads and dimensions of the heavy construction equipment.

This will benefit not only the specialty subcontractor, but also the owner, project engineer or prime contractor, since safety should be important for everybody involved.

This proposal will be submitted to all three members of the Industry-Wide working group (ADSC, PDCA and DFI) as well as to EFFC in hope of a joint research effort.

4.0 PROPOSAL TASK

4.1 Test Method Review and Selection

It is proposed to investigate a series of field tests to supplement (or replace) the commonly used empirical Proof Rolling, Proctor Test and (occasional) Plate Load Test for their suitability and practicability for a field application.

Test Method	Data Measured	Max Depth	Pro/Con	Cost	Source
Stitz DPL (Dynamic Cone Penetrometer)	Penetration Resistance	10-15ft	Ease of use	$ -	In-kind Malcolm
SPT Tripod	Penetration Resistance	10-15ft	Ease of use, correlation to bearing capacity exist	$ 5,000	TMG Manufacturing
Helical Test Probe	Penetration Resistance	50ft	Prototype - not yet build	$ -	In-kind Magnum Piercing
Plate Load Test 300/760mm	Deformation Modulus	5-10ft	Ease of use, limited depth	$ 15,000	Kessler
Lightweight Deflectometer	Deformation Modulus	5ft	Ease of use, limited depth	$ 8,000	Kessler
Proof Rolling	Compaction Level	2-3ft	Not quantifiable, but good coverage of entire platform	$ -	In-kind Site Contractor
Pocket penetrometer in trial pits	Soil Layer Strength	5ft	Ease of use, limited depth	$ 200	Grainger
Contingency (after task group review)	TBD			$ 1,800	
			Total	**$ 30,000**	

Group discussions and additional literature review at the start of the research might identify additional test, which are suitable but not identified at this time.

4.2 Investigation Criteria

- How deep can the method investigate the platform?
- To which frequency does each test have to be employed across the entire site?
- Tolerances and bias due to operator or ground condition influence?
- How practical is each method for our 'field employment' purpose?
- Can the method reliable characterize the quality and capacity of the installed working platform?
- How helpful are they to identify soft spots or poorly backfilled trenches?
- Can relationships to existing SPT or CPT values be established?

Following test have been reviewed but found not suitable.

Test Method	**Data Measured**	**Max Depth**	**Pro/Con**
Clegg Impact Hammer 20kg	Deformation Modulus	3-5ft	Ease of use, limited depth
Ground Penetrating Radar (GPR)	Variation in density	5-10ft	Ease of use, limited depth
CBR (California Bearing Ratio)	Penetration Resistance	2-3 ft	Ease of use, limited depth
ADCP Sapper	Penetration Resistance	10-15ft	Ease of use
Mini CPT (Ramset)	Penetration Resistance	50ft+	Does not penetrate dense granular platform material
Hand Held Auger	Penetration Resistance	10-15ft	Does not penetrate dense granular platform material
Nuclear Gauge Testing	Soil Moisture & Density	1ft	Requires nuclear permit, limited depth

4.3 Execution

After a thoughtful review and selection of available non-standard test, it is planned to visit several construction sites and evaluate the suitability of each test to determine the platform capacity.

It is intended that access to existing project which use man-made work platforms are made available by the members of all 4 organizations and third parties. The field test will be performed by either the contractors themselves or by local independent testing agencies. The results will be reviewed by the working group and the academic partners. The data from the contractors will be treated in confidence. Projects will not be referred to by name, merely a number.

Working group meetings will be held quarterly to review field research progress and findings. After all data are collected, the group will review and discuss the findings in one final meeting.

5.0 DELIVERABLES

Results from all field testing will be combined in one report and include all details about platform and subgrade composition. One detailed presentation will be prepared by the group, so that all organization can use for educational purpose.

One summary paper will be published in the DFI Journal and presented at future industry conferences.

Detailed findings of the field research study and recommendation will also be incorporated in edition 2 of the EFFC-DFI Guide to Working Platforms.

6.0 SCHEDULE

Since the research will heavily rely on available construction projects with different working platforms or subsoil conditions, field testing will need to be spread out over a period of 1-2 years. It is planned to start reviewing available non-standard tests in summer of 2022, if financing is secured in the spring of 2022.
Field testing will start at the end of 2022 after a review period of 3-4 month and a purchasing period of another 1-2 month. All field testing shall be completed by end of 2023 and the final report shall be available by spring 2024.

7.0 ESTIMATED COST

The estimated cost of the field research is summarized in the table below. Please note that equipment purchasing cost are rough estimate and will depend on actual selection of tools by the research group.

Activity	**Cost (US$)**
Testing Equipment Purchase (see table above)	30,000
On site testing of platforms by contractors (in kind contribution) – 5 sites	0
On site testing of platforms by consultant – 5 sites @ $3,000	15,000
Shipping/Trucking of equipment from site to site: 10 sites @ $1,500	15,000
TOTAL	**60,000**

8.0 REQUESTED FUNDING

Several contractors have already committed to help funding this research with their in-kind contribution. It is hoped that DFI and EFFC can fund the equipment purchase and the testing of the first 10 sites.

We therefore kindly request **US$ 30,000** funding from **DFI** the as well US$ 30,000 from EFFC, so that the entire research of $60,000 can be funded at one time.

If ADSC and PDCA as member of the "The Industry-Wide Working Platforms Working Group (WPWG)" will join this effort and help with a contribution, we would be able to extend this research and add additional project sites for further testing.

Attachment:
Stitz DPL Datasheet
SPL Tripod Datasheet