CALCULATION OF TRACK BEARING PRESSURES FOR PLATFORM DESIGN

This document sets out the basic procedure for calculating the track bearing pressures for a crane or piling rig for use in the working platform design process set out in the BRE Report BR470, Working Platforms for Tracked Plant: good practice guide to the design, installation, maintenance and repair of ground-supported working platforms.

It should be noted that the track bearing pressures calculated by the appropriate method for use in the BRE design method are commonly much higher than given by a simple calculation of the total rig weight divided by the total track area.

The calculation of the track bearing pressures in an appropriate manner consistent with the BRE design method is a fundamental requirement of its use, and the use of bearing pressures calculated by any other means could potentially lead to an unsafe working platform design.

All of the figures below are general examples. Platform designs must be based on the actual rig loadings supplied by the piling contractor and the FPS can take no responsibility for any use made of the example information shown.

BEARING PRESSURE DESIGN PROCESS

1. Introduction

The calculation of the bearing pressures under the tracks of a piling rig or crane requires a number of stages.

The first stage is to calculate the theoretical bearing pressure. Using the weights of the various components, for example the undercarriage, main body, counterweight, mast etc. and the eccentricity of the component from the centre of rotation, the overturning moment can be calculated. This needs to be done for the range of operations that will be carried out, e.g. standing, travelling, handling, penetrating, extracting, with all possible jib or mast orientations considered.

Then, by applying the calculated overturning moments to the section provided by the track geometry, the theoretical bearing pressures can be calculated.

This process has to be carried out for all types of envisaged operations and orientations of the rig or crane mast relative to the direction of the tracks.

2. Calculation of theoretical bearing pressures

The factors that need to be considered are broadly:

a) Weight and dimensions of rig / crane components, e.g. mast assembly, base machine
b) Moment arm to centre line of rotation
c) Forces due to line pull, crowd forces
d) Use of stabilising mast foot or outriggers, if any

For convenience, the information required and the basic calculation of the moments generated by the various rig components or forces involved, can be set out as in the following example.

Schedule of Rig Components				
Rig Manufacturer: Digger Cranes		**Rig Type:** DC 007		
		Operation Mode: CFA		
Completed by: ABC		01/01/05	**Checked by:** DEF	
MAIN COMPONENTS				
ITEM		**Weight (kg)**	**Moment Arm(m)**	**Moment (kN.m)**
UPPER WORKS	Mast assembly	5,600	2.74	150
LOWER WORKS	Base machine	21,700	-0.55	-117
SUSPENDED	Auger	5,000	3.41	167
EQUIPMENT	Rotary head	2,150	3.41	72
COUNTERWEIGHT	Counterweight	4,000	-2.45	-96

Information is also required to define the geometry of the tracks and any bearing pads that can be lowered to improve stability.

Track ground bearing length (m)	3.814		
Track pad width (m)	0.700		
Distance between centrelines of tracks	3.300		
Front foot pad bearing area (sqm)	1.500	Dimensions:	1.2m x 1.25m
Front foot pad maximum load (kN)	450	Shape	Rectangular
Front foot pad moment arm (m)	2.74	Moment (kNm)	1,233
Rear foot pad bearing area (sqm)	0	Dimensions:	None
Rear foot pad maximum load (kN)	0	Shape	None
Rear foot pad moment arm (m)	0	Moment (kNm)	

Finally, the forces or loading that may be applied to the rig or crane need to be defined, reflecting a range of operating conditions to be considered.

Load	**Force (kN)**	**Moment Arm(m)**	**Moment (kN.m)**
Maximum extraction force	392	4.000	1,568
Maximum Line pull	10	4.000	40
Maximum penetration force	29	4.000	116
Maximum auxiliary force	10	4.000	40

These factors need to be considered for the various modes of operation, e.g. travelling, lifting, drilling, extracting casing etc. The BRE process considers the various loading conditions under two class headings.

CASE 1 LOADING
These loading conditions may apply when the rig or crane operator is unlikely to be able to aid recovery from an imminent platform failure.

Operations in which this type of loading condition applies could include:

- Standing
- Travelling
- Handling (in crane mode, e.g. lifting a precast concrete pile into the leader, handling casings and reinforcement cages)

CASE 2 LOADING

These loading conditions may apply 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.

Operations in which this type of loading condition applies could include:

- Installing casing
- Drilling
- Extracting an auger
- Extracting casing
- Rig travelling or slewing with a fixed mast which has a foot or fixed load (e.g. pile held in the leader) close to the platform surface.

Also, as the rig / crane may be able to operate with the direction of its mast ranging between parallel and perpendicular to the axis of the tracks, all possible orientations must be considered.

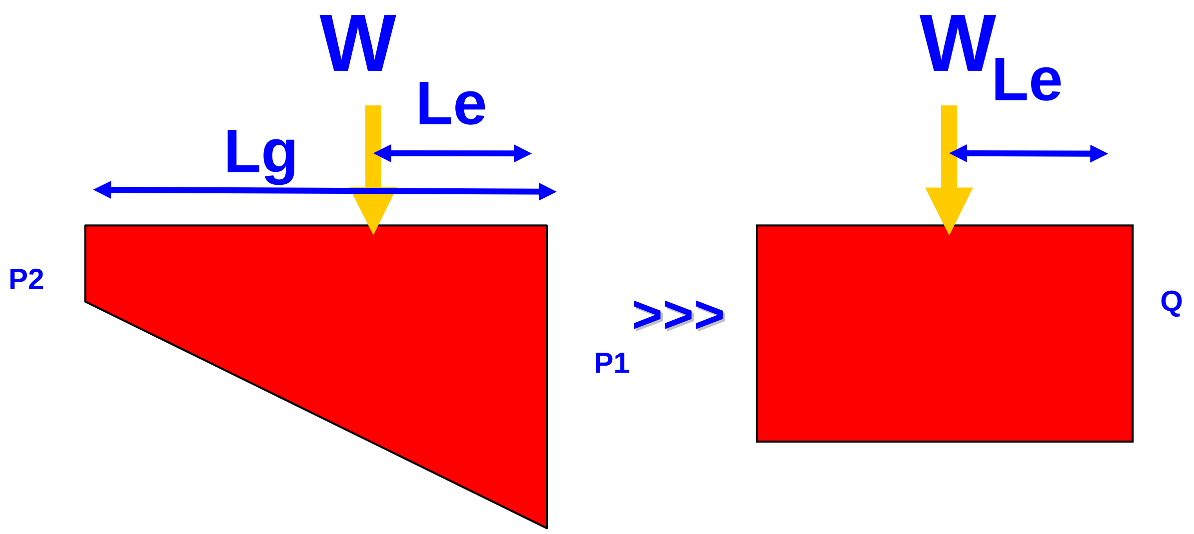
The process of calculating the theoretical pressure under the tracks should follow the basic principles set out in EN 791:1996 Drill rigs – safety and EN 996:1996 Piling equipment – safety requirements. The net moment due to the various weights and forces involved is applied to the area of the tracks in order to calculate the maximum and minimum pressures on each of the tracks.

These pressure distributions may be either rectangular, triangular or trapezoidal, and not necessarily the same pressure will be present under each track.

It may be found that for some loading conditions, the loaded length for each track may be smaller than the full track length that could be in contact with the ground.

3. Calculation of design bearing pressures

The calculated non-uniform theoretical loading can be transformed into equivalent uniform loading using the method described by Meyerhof (1953).



Total track load W = (P1 + P2).Lg/2

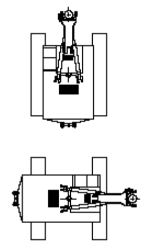
Eccentricity of load centroid Le = Lg.(P1 + 2.P2)/(3.(P1 + P2))

Equivalent uniform bearing pressure for use in design Q = W/(2.Le)

Equivalent track bearing length for use in design L = 2.Le

4. Example Calculation

The following example shows how a design process may be set out, to calculate how the applied loading produces a range of equivalent bearing lengths and pressures, for use in the BRE design method. This process needs to be carried out for each activity envisaged, and the critical combinations found to give the required minimum platform thickness.



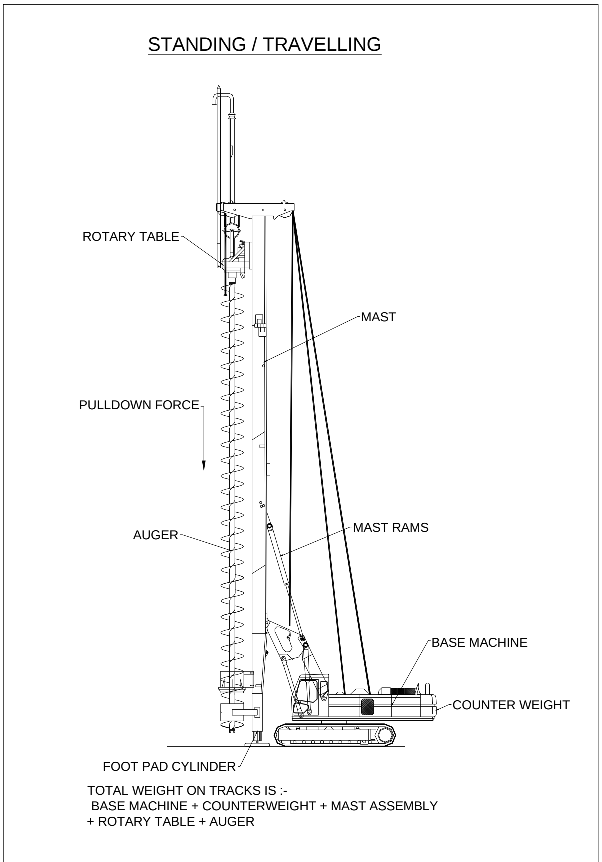
Digger Cranes DC 007	Weight (kg) / Load (kgf)	Distance to CL rotation (m)	Horizontal moment (kNm)	Force (kN)	Max. (kN)	Foot Pad Area (m2)
Lower Works	21700	-0.550	-117			
Counterweight	4000	-2.450	-96			
Upper Works	5600	2.740	151			
Other	0	0.000	0			
Rope / Kelly / Chain Suspended	7150	3.410	239			
Machine Weight (kg)	38450	0.468	176			
Auxiliary Line (kgf)	0	4.000	0	0.00	10.00	
Net Extraction Force (kgf)	32809	3.410	1098	392.00	392.00	
Net Penetration Force (kgf)	0	3.410	0	0.00	29.40	
Front Foot Pads Loading (kgf)	-30887	2.740	-830	303.00	450.00	1.500
Rear Foot Pads Loading (kgf)	0	0.000	0	0.00	0.00	0.000
Others	0	0.000	0	Track Bearing Length (m)		3.814
Track Total Loading (kgf)	40372	1.121	444	Track Width Centres (m)		3.300
				Track pad width (m)		0.700

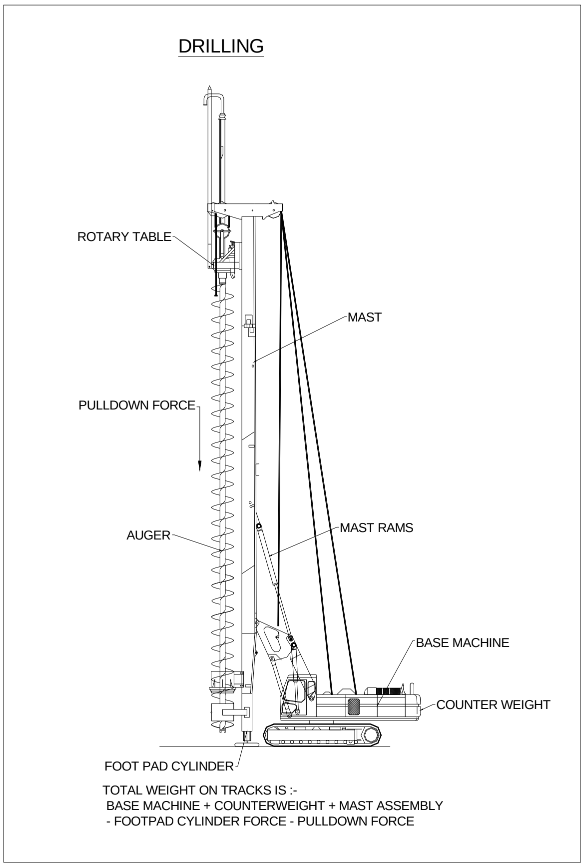
Mode : CFA Extracting

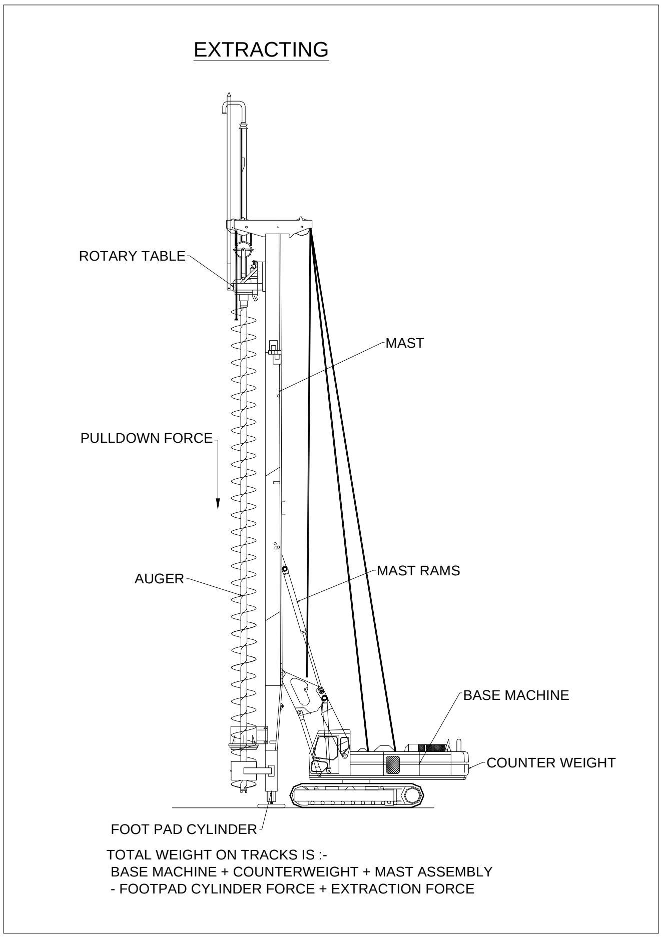
Relative Angle - Upper Body and Tracks (degrees)	Bearing pressure at front of L.H. track (kN/m^2)	Bearing pressure at rear of L.H. track (kN/m^2)	Bearing pressure at front of R.H. track (kN/m^2)	Bearing pressure at rear of R.H. track (kN/m^2)	Max Track loading dimensions: ecc (m)	Max Track loading dimensions: Bearing Len. (m)	Transformation from triangular or trapizoidal to an equivalent rectangular pressure distribution under track maintaining the load centroid — Equivalent Bearing L (m)	Equivalent Bearing Q (KPa)
0	240	0	240	0	1.121	2.359	1.573	180
15	189	0	269	0	1.082	2.474	1.649	202
30	133	0	270	0	0.970	2.810	1.873	202
45	88	0	250	0	0.792	3.344	2.229	188
60	57	4	222	14	0.560	3.814	2.693	167
75	37	14	179	67	0.290	3.814	3.234	145
90	24	24	125	125	0.000	3.814	3.814	125
Front Foot Pads Equivalent Length (m)and Bearing Pressure (kN/m^2)							2.143	202
Rear Foot Pads Equivalent Length (m)and Bearing Pressure (kN/m^2)							0.000	0
Maximum Equivalent Design Values							1.873	202
BRE LOAD CASE (1 or 2)								2

It should be noted that this method assumes that the pressures beneath the mast foot and tracks are equalised due to redistribution and the validity of this should be checked for each individual case.

5. Typical Operational conditions







This guidance has been produced by the Federation of Piling Specialists It is not intended to be used as a design method. Platforms should be designed according to the actual rig loadings supplied by the piling contractor. If expert assistance is required, the services of a competent professional should be sought. Although every effort has been made to check the accuracy and validity of the above guidance, neither the authors nor the Federation of Piling Specialists accept any responsibility for mis-statements contained herein or misunderstandings arising herefrom.

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