1. EN 16228-1../7 & EN 791 & EN 996

2. STABILITY OF THE RIGS;

3. AUSTRALIAN STANDARDS AND REGULATION RELATED TO D&FE;
The piling and drilling rigs are exposed to significant hazards when they are used as intended, and they are associated with the following:

- TRANSPORT
- EQUIPMENT IN SERVICE
- MAINTENANCE
- MOVING ON SITE
- STORAGE
- DISABLING AND SCRAPPING
This document (prEN 16228-1:2011) has been prepared by Technical Committee CEN/TC 151 “Construction equipment and building material machines - Safety”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.


This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

Part 1: Drilling and foundation equipment – Safety – Common requirements

Part 2: Drilling and foundation equipment – Safety – Mobile drill rigs for civil and geotechnical engineering, quarrying and mining

Part 3: Drilling and foundation equipment – Safety – Horizontal directional drilling equipment (HDD)

Part 4: Drilling and foundation equipment – Safety – Foundation equipment

Part 5: Drilling and foundation equipment – Safety – Diaphragm walling equipment

Part 6: Drilling and foundation equipment – Safety – Jetting, grouting and injection equipment

Part 7: Drilling and foundation equipment – Safety – Interchangeable auxiliary equipment
Drilling and foundation equipment - Safety - Part 1: Common requirements

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 181.

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STABILITY OF THE RIG

- CENTRE OF GRAVITY
- CENTRE OF MASS
- EXTERNAL FORCES
STABILITY OF THE RIG

- COG - how it works? ........
1. is it possible to have balance?

- sheave
  - m=0
- rope
  - m=0
- W
- G
- G
- L
- L
2. • is it possible to have balance?
• if YES how much is "W"?
3. TENSION IN THE ROPE IS THE SAME

\[
G - \frac{G}{g} a = \frac{W}{g} + W
\]

\[
G - W = (\frac{G}{g} + \frac{W}{g}) a
\]

\[
\frac{G - W}{G + W} g = a \quad (1^*)
\]
4. LEFT AND RIGHT TO BE IN BALANCE

\[ G - \frac{G}{g} a + \frac{W}{g} a + W = \]

\[ W = \frac{G}{g} a - \frac{W}{g} a \]

\[ \frac{W}{G-W} g = a \quad (2^*) \]
5. **"W"**

- FROM (1*) AND (2*)

\[
\frac{W}{G-W} \cdot g = \frac{G-W}{G+W} \cdot g
\]

\[
\frac{W}{G-W} = \frac{G-W}{G+W}
\]

\[(G-W)^2 = W(G+W)\]

\[W = \frac{G}{3}\]
6. balance

\[ G + G/3 = G \]

\[ w = G/3 \]
**STABILITY OF THE RIG**

**Example/comments:**

- Firstly, as you saw, whenever we have motion of the parts or components on the machines the COG does not remain in the same position.

- The State of the Stability of the machine is not permanent and is changing all the time during the operation.

- All calculations done by designer are related to the temporary and particular state and position of the machine as a whole assembly and motions of its components.

- Position of COG of the DFE can be used for considering the STABILITY of the DFE only as temporary and it is changing position all the time.

- Because the COG does not remain in the same position, the STABILITY ANGLE is not STATIC and will change its value at all times during the DFE operation.

- Consequently, the ground pressure imposed on the ground by DFE is not constant and is changing its magnitude all times during the process of drilling or piling.
STABILITY ANGLE
EN-791
EN996
STABILITY ANGLE
EN-791
EN996

Choose 1 if beta is lower than or equal to 2 degrees.
Choose 2 if beta is greater than 2 degrees.

Figure 6: Tipping lines of crawlers
Figure 3: Tipping lines for wheel mounted carrier when tramming

Figure 4: Crawler mounted drill rig

Figure 5: A pair of support points form a tipping line
STABILITY OF THE RIG

Temporary Stability Reference Line
TSRL
DRILLING & FOUNDATION EQUIPMENT
SAFETY –as prEN16228-1/……/7

TIPPING LINES
ISO4305
TIPPING LINES
ISO4305
STABILITY ANGLE
EN-791
DRILLING & FOUNDATION EQUIPMENT
SAFETY – as prEN16228-1/……./7

STABILITY ANGLE
EN996
Figure B.3: Load case 3 (in service; dynamic: released and/or grounded load)

\[ \Sigma M_s, \Sigma M_v, \text{ and } M_{DYN} > 0 \]

where

\[ M_s = \Sigma G_x, X_s, G_L, A_L \]
\[ G_L = \Sigma G_{L1}, G_{L2}, ... \]
\[ M_{DYN} = \Sigma M_x, \Sigma G_L, N_L \]
### Required Stability Angles prEN16228-2

<table>
<thead>
<tr>
<th></th>
<th>Stability class SN (normal conditions)</th>
<th>Stability class SC (special conditions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travelling</td>
<td>8 degrees</td>
<td>5 degrees + $\beta$ (see below)</td>
</tr>
<tr>
<td>Operating and tramming</td>
<td>5 degrees</td>
<td>1.5 degrees + $\beta$ (see below)</td>
</tr>
</tbody>
</table>

---

It is also required a static stability angle of 5 degrees + $\beta$ (see below) calculated without dynamic accelerations and wind loads.

SN, SC are the stability classes (see explanations below).
SN, SC are the stability classes (see explanations below).

The manufacturer shall provide a capacity table class SN in any case.

Tipping angle of stability class SN is applicable to all types of foundation equipment.

The manufacturer may provide an additional capacity table class SC which is based on the assumption that all of the following conditions are fulfilled:

a) the ground shall support the machine and can reliably withstand the supporting forces, without significant unintended displacements or taking into account their affect on stability (support by e.g. timber plates, steel plates and/or improved ground surface may be required). This shall also be shown in the case, if supports (those not causing rigid body movement) become unloaded and thus cause maximum forces at other supports;

b) Masses of relevant parts of the machine shall be evaluated by weighing with an accuracy of ± 2,5 %;

c) Stability calculations of structures where the design calculation or the practice show that deformations and displacements under load may significantly affect the stability of the equipment, shall take the above mentioned factors into account.

d) When using tipping line 1 as defined prEN 16228-1, Figure 2, then the required tipping angle must be increased by β.

The user shall be informed by the operator’s manual and the capacity table that stability table for class SC only may be used if the requirement a) is tested and secured.
The manufacturer shall provide a capacity table class SN in any case.
The user shall be informed by the operator's manual and the capacity table that stability table for class SC only may be used if the requirement a) is tested and secured.
5.5 Stability

5.5.1 General stability criteria

Drill rigs shall be so designed and constructed that they are sufficiently stable under the intended operating conditions, e.g. transport, tramming, parking and drilling and that there is no risk of overturning and falling. The stability shall be verified by calculation.

The following stability criteria and calculations refer to mobile and stationary drill rigs but are not applicable to drill rigs fixed to the ground or a foundation. For those drill rigs the moments from weights and forces shall be taken into account when calculating and designing the anchoring of the drill rig.

The stability angles, α, as defined in 3.9 and 5.5.2 shall not be less than 10° in any directions when tramming and be not less than 5° under any other conditions.

NOTE: The stability angle of 10° includes also a margin for the effects of the dynamic forces from acceleration and braking of the total drill rig.
### Track Pressure

**Load and Stress Diagram**

<table>
<thead>
<tr>
<th>Position of the Single Load $P$</th>
<th>Ground Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e = 0$</td>
<td>$\sigma = \frac{P}{bd}$</td>
</tr>
<tr>
<td>$e &lt; \frac{d}{6}$</td>
<td>$\sigma_2 = \frac{P}{bd} \left( \frac{6e}{d} \right)$</td>
</tr>
<tr>
<td>$e = \frac{d}{6}$</td>
<td>$\sigma_1 = 0$</td>
</tr>
<tr>
<td>$e &gt; \frac{d}{6}$</td>
<td>$\sigma = \frac{2P}{3bc}$</td>
</tr>
<tr>
<td>$\sigma = \frac{4P}{bd}$</td>
<td>$e = \frac{d}{3}$</td>
</tr>
</tbody>
</table>

**Figure F.1 — Ground Pressure**
DRILLING & FOUNDATION EQUIPMENT
SAFETY –as prEN16228-1/……/7

TRACK PRESSURE
DRILLING & FOUNDATION EQUIPMENT
SAFETY – as prEN16228-1/……../7

TRACK PRESSURE
DRILLING & FOUNDATION EQUIPMENT
SAFETY – as prEN16228-1/……/7

TRACK PRESSURE
Ground pressure Banut 655 (according to EN 996)

- Machino type: Banut 655
- Carrier: 540.6.233
- Customer: ThyssenKrupp GFT
- Order no: A 58 750

Ground pressure in kN/m²; mast inclination 5,5° to front, dependent on pile length

<table>
<thead>
<tr>
<th>Inclination</th>
<th>Maximum ground pressure [kN/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>679.0</td>
</tr>
<tr>
<td>Side</td>
<td>0.0</td>
</tr>
</tbody>
</table>

- Height: dependent on pile length
- Reach: Main boom complete retracted
- Tracks: extended
- Weight of attachments (SuperRam 10000XL) [kg]: 15,200
- Pile weight [kg]: 5,000
- Carrier: SR 40T
- Underrailage: 350/44 CVT - 9001
- Operation weight (with SuperRams 10000XL): 85,600

Track Pressure
CONSEQUENCES - SOMETIMES THEY ARE ONLY ACCIDENTS
CONSEQUENCES - SOMETIMES THEY ARE ONLY ACCIDENTS
CONSEQUENCES - SOMETIMES THEY ARE ONLY ACCIDENTS
STEEL WIRE ROPES
## Ropes Safety Factors:

<table>
<thead>
<tr>
<th></th>
<th>EN 16221</th>
<th>EN 791</th>
<th>EN 996</th>
<th>AS 1418</th>
<th>AS 2759</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running ropes (RR)</td>
<td>3</td>
<td>3</td>
<td>3.55</td>
<td>5*</td>
<td>5</td>
<td>*comments</td>
</tr>
<tr>
<td>RR for boom &amp; Leader/erection</td>
<td>3</td>
<td></td>
<td>3.55/3.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stationary ropes (SR) / erection</td>
<td>3</td>
<td></td>
<td>3.0/2.73</td>
<td>4*</td>
<td>4</td>
<td>*comments</td>
</tr>
<tr>
<td>SR for erecting and dismantling</td>
<td>2.5</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free fall drop hammer</td>
<td>3</td>
<td></td>
<td>3.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed and pulling down ropes</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>Cable and percussion drilling</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Instruction books for drilling and foundation equipment;

- Operators manual;
- Maintenance instructions;
- Instructions for inspection;
- Spare parts book(s)
- Transport and assembly instructions;
- Test report, static and dynamic test carried out by manufacturer or authorized representative.
List of drilling and foundation equipment; (drawings) used in:

- Civil engineering,
- Geotechnical engineering,
- Water well drilling,
- Geothermal installation,
- Lend fill drilling,
- Underpinning, tunneling, mining,
- For use above ground as well as underground.
DRILLING & FOUNDATION EQUIPMENT
SAFETY –as prEN16228-1/........./7

○ BLANK
For routine maintenance the manufacturer shall provide means to handle and instructions how to handle components over 25 kg in weight or which are otherwise awkward to handle.

Any component, for example filters, engines, hydraulic tanks, etc. (excluding hoses), containing fluid which can cause risk of pollution, personal contamination or slip hazard, shall be designed and located so that during service and maintenance the fluid can be directed under control into a suitable receiving container.

6 Verification of the safety requirements and/or protective measures

6.1 General

Where applicable, individual components may be separately verified or tested. Conformity to the safety requirement and/or protective measure (specified in Classes 5) shall be verified by the methods given in Tables 3 and 4.

6.2 Types of verification

<table>
<thead>
<tr>
<th>Table 4 — Verification methods for requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection</td>
</tr>
<tr>
<td>Measurement</td>
</tr>
<tr>
<td>Testing</td>
</tr>
<tr>
<td>Drawings and calculations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5 — Methods to be used to verify conformity with the safety requirements and/or protective measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clause number</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
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<tr>
<td>5.1</td>
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<tr>
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<tr>
<td>5.1.2</td>
</tr>
<tr>
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</tr>
<tr>
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<tr>
<td>5.2.4</td>
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<tr>
<td>5.3</td>
</tr>
</tbody>
</table>
1. **EN 16228-1../7 & EN 791 & EN 996**

2. **STABILITY OF THE RIGS;**

3. **AUSTRALIAN STANDARDS AND REGULATION RELATED TO D&FE;**
AS1418-5/11.6.3 Requirements

- (c) *Track type crane, on crawlers*

The tipping condition of a track-type crane supporting a load on crawlers is deemed to have been reached when *two-thirds of the track* that is normally *in contact* with the *supporting surface* remains in contact with the supporting surface and the application of an additional load moment causes more than *one-third of the track* to lose contact with the *supporting surface*. 
On 19 September 2008 a serious incident occurred near Tully in North Queensland when a 30 metre tower of a pile driving rig became detached from a lattice boom crawler crane and fell with a 12 metre long concrete pile. One worker, located on the ground in front of the crane, was fatally injured. The crane operator was critically injured when one end of the pile became embedded in the crane cabin as a result of the fall.

- Rig Operator killed in piling machine accident -16/08/2013;
- Worker Killed During Pile Driving Operation/ Excavator Toppled and Killed Operator-16/08/2013;
CONSEQUENCES - FATAL
CONSEQUENCES - SOMETIMES THEY ARE ONLY ACCIDENTS
CONSEQUENCES - FATAL

On 19 September 2008 a serious incident occurred near Tully in North Queensland when a 30 metre tower of a pile driving rig became detached from a lattice boom crawler crane and fell with a 12 metre long concrete pile. One worker, located on the ground in front of the crane, was fatally injured. The crane operator was critically injured when one end of the pile became embedded in the crane cabin as a result of the fall. It is understood an attempt was being made to lift the pile into position under the hydraulic hammer, with the auxiliary hook on the mobile crane.

A photograph of the incident scene is shown in Photograph 1.

Photograph 1 - Incident Scene

Photograph 2 - Swivel which connects the piling rig tower to the boom head of the crane
CONSEQUENCES - FATAL

Figure 1: The dolly was being extracted from the ground when it swung and struck the deceased.
CONSEQUENCES - FATAL

Rig Operator Caught between Hydraulic Piston and Guide Pin of the Hydraulic Jack-in-Piling Machine

On 20 April 2013, the operator of a hydraulic jack-in-piling machine was found pinned in between the piston and the guiding pin of the piling machine. He was freed and sent to the hospital where he subsequently succumbed to his injuries.

Figure 1: Hydraulic Jack-in-Piling Machine.

Figure 2: Location where Deceased was pinned.
HISTORY

Lawrence Construction drives timber piles in 1929 with a steam hammer mounted on a skid.
In the early 1950s, Lawrence Construction drives battered pile with a Marion crane and steam hammer. The hammer is powered by steam from the crane.
DRILLING & FOUNDATION EQUIPMENT
SAFETY – as prEN16228-1/……/7
DRILLING & FOUNDATION EQUIPMENT
SAFETY –as prEN16228-1/....../7
Thanks Omer,
I still like to learn something new every day so the longer I live the more I know. That's my excuse any way.
The trouble is I started my technical education with a slide rule and geometric theorems were still identified by the numbers that Euclid gave them, I've got a lot of computer catch up to do.

thank you Omer for your explanation.

Len
On 16 Nov, 2013, at 10:56 PM, remocila@remocila.com <remocila@bigpond.com>
EDUCATION NEVER STOPS................

.....so the longer I live the more I know.

in memory of Len S. -grate engineer