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VARIABLE RATED LIFT CAPACITIES ON EXCAVATORS

Introduction

CMEIG members have been receiving requests from tracked excavator users to provide greater clarity regarding aspects of their use for lifting freely suspended loads as a secondary function associated with their normal application. This paper offers tracked excavator users with a broad understanding of some of the pros and cons and supporting information and resources, to help tracked excavator users make an informed decision.

CMEIG has identified a requirement within an Australian Standard (AS 1418.8) related to variable load lifting and rated capacity with excavators, that is inconsistent with industry and current technology trends, the related international (ISO) standards, and the position in other global markets. CMEIG intends to resolve the issue through engagement in the Australian Standards arena and through ongoing engagement with the various regulatory bodies. However, in the interim, this paper offers some commentary.

Problem Statement

AS 1418.8, Section 5 identifies requirements for earthmoving equipment, including tracked excavators when used for lifting freely suspended loads as a secondary function associated with the normal applications of the equipment (e.g. lifting and moving pipes, unloading construction equipment, manoeuvring accessories associated with the equipment).

AS 1418.8 focuses on a single rated lift capacity (as opposed to variable rated lift capacities) for lifting freely suspended loads, stating the following:

> *"…5.3 RATED CAPACITY*
> *5.3.1 Requirements for rated capacity at maximum reach/radius*
> *The rated capacity shall be the maximum mass (expressed in kilograms) that may be handled at the maximum lift point radius, or reach, expressed in metres in the most adverse configuration for each lift point without the strength, hydraulic, and stability requirements being exceeded…"*

And states the following in relation to variable rated lift capacities,

> *"…where variable rated capacities are specified, all requirements of AS 1418.5 and this Section shall apply…"*

Note that AS 1418.5 is an Australian modified adoption of *EN13000:2010, Cranes-Mobile cranes*. The scope of this standard states the following:

> *"…This European Standard is applicable to the design, construction, installation of safety devices, information for use, maintenance and testing of mobile cranes as defined in ISO 4306-2…"*

Figure 1 is a simplified graphic to help explain this situation in AS 1418.8:

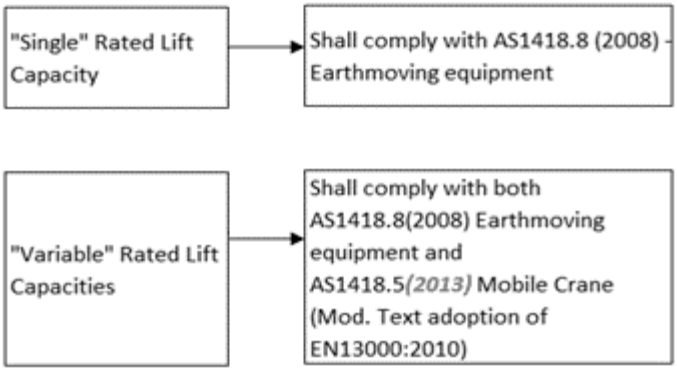

Figure 1 - AS 1418.8, on the topic of single and variable rated lift capacities

In the interpretation of CMEIG, AS 1418.5 was not written with excavators lifting incidental loads in mind. Its requirements are therefore difficult to interpret and apply to excavators. This means that in Australia, excavators have typically been limited to a single rated lift capacity.

Situation Today

In practice, this means that a typical 20 tonne excavator is limited (via administrative risk controls such as labels and instructions) to a single rated lift capacity in the range of 3000 kg since this is its maximum mass that may be handled at the maximum reach (9.0 m) in the most adverse capability.

Note that this typical machine is actually capable of safely lifting larger loads at different boom and stick, height and reach, positions. By way of example, the afore-mentioned excavator can lift 3600 kg at 7.5m reach (boom height of 0 m). 7200 kg at 4.5m reach (boom height of -1.5m), and 6600 kg at 3.0 m reach (boom height of 0m). Figure 2 provides a visual representation of this detail.

		1.5 m (5.0 ft)		3.0 m (10.0 ft)		4.5 m (15.0 ft)		6.0 m (20.0 ft)		7.5 m (25.0 ft)				
														m ft
7.5 m	kg											*2050	*2050	7.75
25.0 ft	**lb**											***4,550**	***4,550**	**25.11**
6.0 m	kg									*3250	2750	*1950	*1950	8.73
20.0 ft	**lb**											***4,300**	***4,300**	**28.47**
4.5 m	kg							*4450	4150	*4150	2750	*1950	1800	9.30
15.0 ft	**lb**							***9,700**	**8,900**	***9,100**	**5,800**	***4,250**	**3,950**	**30.44**
3.0 m	kg			*10 700	*10 700	*6750	6250	*5300	3900	4150	2600	*2000	1600	9.55
10.0 ft	**lb**			***22,750**	***22,750**	***14,550**	**13,450**	***11,400**	**8,350**	**8,900**	**5,550**	***4,400**	**3,550**	**31.33**
1.5 m	kg					*8500	5600	5800	3600	4000	2450	*2200	1550	9.53
5.0 ft	**lb**					***18,250**	**12,100**	**12,400**	**7,700**	**8,550**	**5,250**	***4,750**	**3,450**	**31.26**
Ground	kg			*6250	*6250	8800	5200	5550	3400	3900	2350	*2450	1650	9.22
Line	**lb**			***14,350**	***14,350**	**18,850**	**11,200**	**11,850**	**7,250**	**8,300**	**5,000**	***5,350**	**3,600**	**30.24**
-1.5 m	kg	*5750	*5750	*9750	*9750	8600	5050	5400	3250	3800	2300	*2900	1850	8.59
-5.0 ft	**lb**	***12,850**	***12,850**	***22,100**	**21,150**	**18,450**	**10,900**	**11,600**	**7,000**	**8,200**	**4,900**	***6,350**	**4,100**	**28.15**
-3.0 m	kg	*9700	*9700	*13 800	10 100	8650	5100	5400	3250			*3700	2400	7.56
-10.0 ft	**lb**	***21,800**	***21,800**	***29,800**	**21,600**	**18,550**	**10,950**	**11,600**	**7,000**			***8,200**	**5,300**	**24.68**
-4.5 m	kg			*11 350	10 500	*7900	5300					*4050	3700	5.93
-15.0 ft	**lb**			***24,350**	**22,500**	***16,900**	**11,400**					***8,900**	**8,300**	**19.26**

Figure 2 - Typical variable rated lift capacity chart for a tracked hydraulic excavator

From an industry standpoint, the limitation placed on excavators lifting freely suspended loads as a secondary function associated with the normal applications of the equipment, limits productivity. It also results in Australia having a different approach to the rest of the world. In some cases, this may limit Australia's access to new technologies and solutions. In most cases, it requires Australian distributors and suppliers of excavators to amend manufacturer provided lift charts and guidance to suit this unique Australian requirement.

Global Perspective

As a matter of reference, CMEIG offers some commentary on practices globally in this area. CMEIG understands international best practice to be documented within the following standards:

ISO 20474.1 - Earth Moving Machinery - Safety, Part 1: General Requirements
ISO 20474.5 - Earth Moving Machinery - Safety, Part 5: Requirements for Hydraulic Excavators
ISO 10567 - Earth-moving machinery - Hydraulic excavators - Lift capacity

Note that the afore-mentioned standards differ from the position within AS 1418.8 outlined previously. In particular, the ISO standards do not rely on conformance to a mobile crane standard for variable rated lift capacities for incidental lifting, rather the ISO standards identify requirements for variable rated load lifting.

These international standards are the default reference for today's non-Australian manufacturers of excavators i.e. the unique Australian requirements create a technical, support and application challenge for excavator manufacturers and Australian user's due to the divergence in Australia from global norms.

Arguments 'For' and 'Against'

There are historical arguments against the use of excavators for lifting, and then more specifically for variable rated lifting capacities as opposed to a single rated lift capacity. To help end users make an informed decision, below is a comparison between some of these arguments and some counter-arguments:

<table>
<tr><th>Arguments 'Against'</th><th>Arguments 'For'</th></tr>
<tr><td>Excavator hydraulics historically not designed for precision lifting applications</td><td>Modern hydraulic systems on hydraulic excavators are capable of very precise boom and stick movements. In addition, some excavators have selectable 'lift modes' focused on supporting the incidental lifting of freely suspended loads</td></tr>
<tr><td>Visibility limitations while lifting freely suspended loads</td><td>Visibility aids such as supplemental cameras and 360-degree vision systems are becoming readily available on hydraulic excavators. Proper task and jobsite planning can also reduce this risk</td></tr>
<tr><td>Lifting applications with an excavator can require movement of both the boom and stick during a specific lifting manoeuvre</td><td rowspan="8">Additional limiting and indicating devices (Rated Capacity Indicators) can now be installed to excavators to support safe lifting operations.

These devices provide two primary safety functions such as lifting stability and machine lifting envelope monitoring. Both safety functions are achieved through real time monitoring of some or all of the machine's moving parts (booms, other articulations and etc) and its environment (inclination, reach, load and etc) and actively determining the safety of the current operation where appropriate limits have been set.

These systems, along with existing systems on the machine (e.g. level sensors, visibility to work site including through visibility aids etc.) help excavator operators to make informed decisions about the machine stability in various boom and stick positions and stationary vs. pick and carry applications. In each case, the operator has insight into the operational proximity to a rated capacity limit

In essence, such systems can provide operators with the required data to make better informed decisions around variable lifting capabilities, thereby reducing the reliance on low-level administrative risk-controls such as is the case with single-rated lift capacity ratings.</td></tr>
<tr><td>Dynamic stability considerations introduced by 'pick and carry' applications</td></tr>
<tr><td>Lifting on slopes and the impact on lifting capability due to a shift in excavator center of gravity</td></tr>
<tr><td>Traditional hydraulic load indicator system 'nuisance alarm's' in particular cases</td></tr>
<tr><td>The operator may not know how close they are to a stability/lifting limit. Limiting excavators lifting freely suspended loads as a secondary function to a single (i.e. worst case) load limit provides a very conservative approach in the absence of a means to measure proximity to stability/lifting limits.</td></tr>
<tr><td>A rule-based approach (i.e. administrative control) to follow regarding rated load, rather than relying on the operator determining what the rated load is in each case of boom/stick height and reach</td></tr>
<tr><td>Training and capability of excavator operators and other bystanders to conduct lifting operations with excavators</td></tr>
<tr><td>Excavators are for digging, cranes are for lifting - Excavators lifting components need to be crack tested.</td><td>When used as intended, the structural loads exerted during lifting freely suspended loads are generally aligned with (or less than) the loads exerted on excavator structures during normal</td></tr>
</table>

	digging operations. Excavators and their lifting components are also typically designed and built considering OEM-know-how and relevant international standards such as those mentioned in this document, ensuring they are fit for purpose for the intended digging and lifting use-cases. Also note, there are lifting applications incidental to where a tracked excavator is used for digging, where it may be impractical and potentially unsafe to require a purpose-built crane is used. *By way of example, the scenario where an excavator has dug a pipe trench, and is used for incidental lifting to place pipe into the trench. If the intention was to require a purpose-built crane to do this task, the wait-time and crane hire-out rates may add significant cost to the end user. Manoeuvring and stabilising a rubber tired, rigid-chassis crane may create site access, ground control and traffic management issues, all of which can add safety related risk and complexity to a relatively simple task that can be done safely using a tracked excavator.*

Summary

When properly used, new technologies in conjunction with modern tracked excavators can address many of the historic arguments against the use of tracked excavators for lifting freely suspended (variable) loads incidental to their primary purpose.

There are a number of inconsistencies in AS 1418.8 in comparison to the global body of knowledge captured in ISO 10567 and applicable parts of ISO 20474. CMEIG intends to work towards updating AS 1418.8 to bring it in line with global best practice.

CMEIG encourages readers of this document to bear in mind that any technology should not be seen as a solution that in isolation can absolve the user of using a task based risk assessment approach, using good judgement, and appropriate knowledge and training. The user should also always understand the weight and characteristics associated with the load they are lifting, prior to conducting any lifting activity.

For more information, contact your product manufacturer, supplier or authorised agent.

Associated clarifications

Controlled Lowering Devices (aka. Crane Valves, Hose Burst Valves)

CMEIG is aware of a requirement within AS 1418.8, Section 5 for the fitment of controlled lowering devices where the rated lift capacity at maximum radius/reach is greater than 1 tonne, and that the controlled lowering device meet the requirements of ISO 8643. It is CMEIG's position where an excavator fitted with the afore-mentioned features is used to lift variable rated loads, the requirement for controlled lowering devices should be determined based on a designated lift capacity greater than 1 tonne in any lifting position/orientation, rather than only at the maximum radius/reach.

Excavators not fitted with Rated Capacity Indicators

CMEIG recognise end users may have alternative risk mitigations in place. It is CMEIG's position that excavators not fitted with Rated Capacity Indicators continue existing best-practice.

66% Pick and Carry from Table 5.5 of AS 1418.8

CMEIG is aware of a difference between AS 1418.8 and global practice as documented in ISO 10567 which is summarised in the table below:

Detail	**AS 1418.8 - 2008**	**ISO 10567 - 2007**
Rated Hydraulic Capacity Limit	"87% of the hydraulic capacity at maximum reach/radius"	"87% of the smaller of boom or arm hydraulic lift capacity at specific lift-point positions"
Stationary Stability Requirement for Load Rating Condition	75% of tipping load	75% of tipping load
Pick and Carry (General) Stability Requirement for Load Rating Condition	66% of tipping load	75% of tipping load

CMEIG understands that the approach in AS 1418.8 for 'pick and carry' applications differs from the approach used globally, as documented in ISO 10567. CMEIG understands the global approach in relation to tracked excavators assumes that the 75% stability requirement is sufficient to address both the typical stationary, as well as pick and carry applications. CMEIG also notes that Rated Capacity Indicator systems provide a means for the operator to dynamically monitor proximity to stability limits.

Marking of Rated capacity for variable rated load lifting

It is CMEIG's position where an excavator fitted with the afore-mentioned features is used to lift variable rated loads, the identification of a specific lift rating at the designated lift point may be replaced with language or a pictograph that the machine is fitted with a rated capacity indicator. The viewer should then refer to the guidance in the Operation and Maintenance Manual and the display in the excavator cab. An ISO 10567 variable rated capacity chart (similar to that shown in Figure 2) should also be provided in the cab.

Additional sources of guidance to consider (note that some guidance may be dated)

1. ISO 10567 - Earth-moving machinery -- Hydraulic excavators -- Lift capacity
   https://www.iso.org/standard/32386.html

2. ISO 20474.1 - Earth Moving Machinery - Safety, Part 1: General Requirements
   https://www.iso.org/standard/60734.html

3. ISO 20474.5 - Earth Moving Machinery - Safety, Part 5: Requirements for Hydraulic Excavators
   https://www.iso.org/standard/60738.html

4. AS 1418.8 - Cranes, hoists and winches – Special purpose appliances
   https://infostore.saiglobal.com/en-au/standards/as-1418-8-2008-r2018--1022447/

5. Safe Work Australia publishes information regarding the safe use of mobile plant as a crane containing specific information relating to excavators lifting freely suspended loads
   https://www.safeworkaustralia.gov.au/cranes

6. Workplace Health and Safety Queensland, Technical Guidance Note – Earthmoving equipment – Burst protection on earthmoving equipment used as cranes:
   https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0017/83222/earthmoving_burstprotection.pdf

7. Workplace Health and Safety Queensland – Mobile Crane Code of Practice 2006
   https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0008/58175/mobile-crane-cop-2006.pdf