Evaluation of End Buffer Impact Forces

Trevor Haas
Senior Lecturer
Stellenbosch University
South Africa
trevor@sun.ac.za

Peter Dunaiski
Professor
Stellenbosch University
South Africa
ped@sun.ac.za

Philippe Maincon
Senior Scientist
Marintek
Norway
Philippe.Maincon@marintek.sintef.no

Trevor Haas, born 1971, received his Ph.D. (Structural Engineering) from Stellenbosch University

Peter Dunaiski, born 1950, received his Ph.D. (Structural Engineering) from Stellenbosch University

Philippe Maincon, born 1969, received his Dr. Ing. (Marine Engineering) from NTNU, Norway.

Summary

The current codes of practice for the design of Electric Overhead Travelling Crane (EOHTC) Support Structures, which were reviewed in this study, do not explicitly account for the interactions between the EOHTC and the crane supporting structure (gantry). This implies that the codes consider the analysis of the EOHTC and the gantry as two uncoupled systems, thereby incorrectly assessing the forces transferred from the EOHTC to the gantry. A study was commissioned to determine the effect of analysing the EOHTC and gantry as a coupled system. This was achieved through a series of full-scale experimental tests in a laboratory environment and extensive Finite Element Analysis (FEA) simulations. The impact forces obtained from the FEA simulations were used to determine the maximum end buffer impact forces for a given level of reliability.

Keywords: end buffer impact forces, FEA

1. Introduction

The assessment of the member forces are based on the EOHTC and the crane supporting structure acting as two decoupled systems. The codes of practice make this simplification due to the complexity of the interactions between the various components of the EOHTC and the crane supporting structure. Significant errors in the member forces can arise from this simplification. This paper specifically focuses on determining the end buffer impact forces (Horizontal Longitudinal Forces) when the EOHTC collides with the end stops.

2. Methodology of Investigation

This investigation was conducted through a series of experimental tests which were used to calibrate the FEA model. Advanced FEA simulations were conducted on a set of parameters which were identified that could have a significant effect on the end buffer impact force response. This was achieved by changing a single parameter at a time, while keeping the remaining parameters constant. The FEA end buffer impact forces were used to determine the maximum end buffer impact force which required solving a constraint optimization problem, which was done using the Lagrange multipliers. The codified results were compared to the results obtained from the constraint optimization problem to determine its effectiveness in predicting realistic estimates for the end buffer impact forces.

3. Critical Parameters Which Influences the End Buffer Impact Force Response

The differences between the analysis philosophies and the fact that the codes of practice consider the EOHTC and the crane supporting structure as a decoupled system can lead to impact forces which are significantly different from the actual maximum end buffer impact forces. Beside the above, the codes of practice also ignore certain critical parameters which could have a significant effect on the end buffer impact force response. Table 1 presents a list of the parameters which the codes of practice account for and also the critical parameters which are ignored. Advanced FEA simulations were conducted using these parameters when the payload was centrally positioned on the Crane Bridge and hoisted 0.15m and 2.20m above ground level for the Power-Off and Power-On conditions.

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Table 1 Summary of the criteria used to determine the end buffer impact forces specified by the various codes and guidelines

Code / Guideline	Impact speed	Impact speed reduction factor	Crane and crab mass	Payload mass	Dynamic factor to account for dynamic effects	Vertical position of the payload during impact	Horizontal position of the payload during impact	Damping charac-teristics (Energy absorption of end buffers)	Longitu-dinal misalign-ment of the end stops	Power off (Mini-mum load during impact)	Power on (Maxi-mum load during impact)
SABS 0160- 1989 Method (a) & Method (b)	× √	× ×	√ √	× ×	× ×	× ×	× ×	× √	× ×	√ √	× ×
DEMAG	√	×	√	×	×	×	×	√	×	√	×
EN 1991:3 & SANS 10160	√	√	√	√	√	×	×	√	×	√	×
AS 1418.18 : 2001	√	×	√	×	×	×	×	√	×	√	×
AS 1418.1 : 1994	√	√	√	×	×	×	×	√	×	√	×
AISE No. 13: 1997	√	×	√	×	×	×	×	√	×	√	×

4. Comparison of the Impact Forces Obtained from the Constraint Optimization Problem and the Code of Practice

Figure 1 shows the codified impact forces and the results obtained from the constraint optimization problem for various levels of reliability.

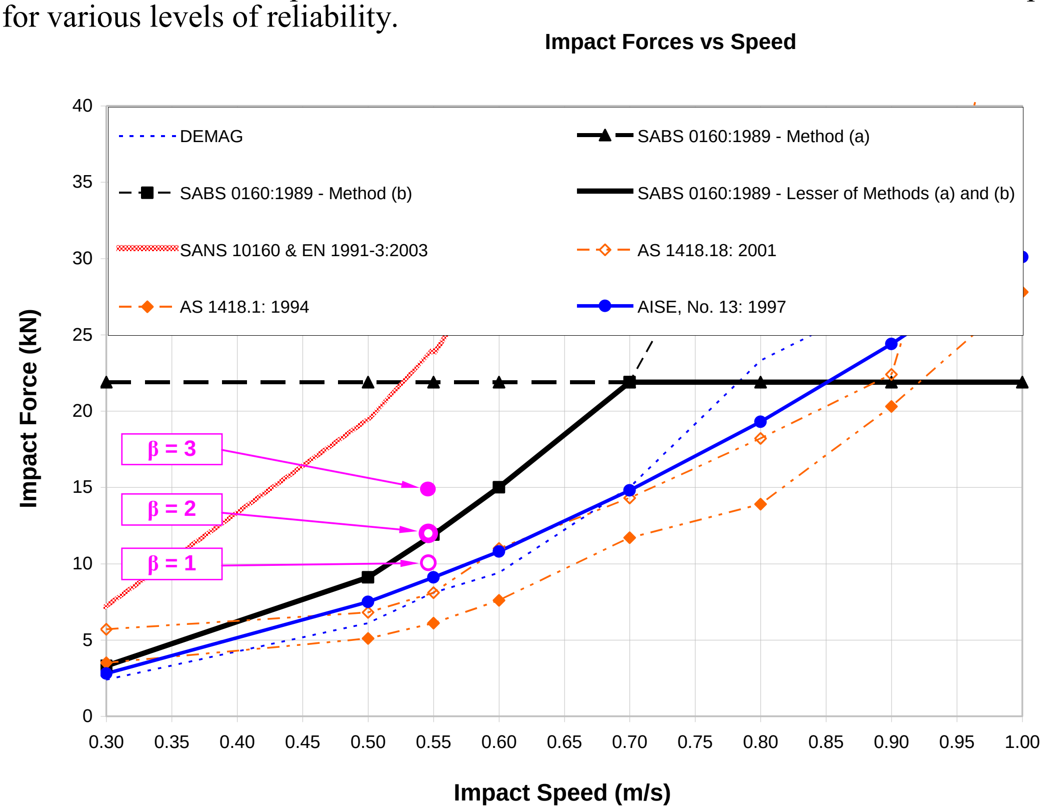

Figure 1 Comparison of the codified impact forces with the maximum end buffer impact force determined using the Lagrange multipliers.

5. Conclusion

The majority of the codes of practice are calibrated to a reliability index of β = 3 or greater. The Eurocode and proposed South African code substantially over estimate, while the remaining code underestimate the end buffer impact force for a given reliability index of β = 3. Thus these codes have a probability of at least 2.3×10^{-2} of being exceeded.