Industrial Engineering & Management

ISSN: 2169-0316

Wheatley, Ind Eng Manage 2018, 7:4
DOI: 10.4172/2169-0316.1000273

Case Study Open Access

Design of Industrial Lifting Crate Rated for 1 Tonne Load

Greg Wheatley*

College of Science and Engineering, James Cook University, 1 James Cook Dr, Douglas QLD 4814, Australia

***Corresponding author:** Greg Wheatley, College of Science and Engineering, James Cook University, 1 James Cook Dr, Douglas QLD 4814, Australia, Tel: +61747814137; E-mail: greg.wheatley@jcu.edu.au

Received date: Dec 11, 2018; **Accepted date**: Dec 17, 2018; **Published date**: Dec 24, 2018

Abstract

This article provides a summary of the design and operating parameters for the Lifting Crate. Finite element analysis via Autodesk Inventor was used to determine the structural stresses induced by the forces. A 2350 kg load has been nominated for design purposes in order to satisfy a working load limit of 1000 kg through Australian Standard AS4991 Lifting Devices and AS3990 Mechanical Equipment – Steelwork. The standards have been utilized for determining the suitability of the design. The design meets the requirements of the standards for the proposed loads.

Keywords: Lifting crate; AS4991; AS3990

Introduction

The Lifting Crate is used in a factory setting to only transport material from the factory floor to the top of a piece of equipment. The Lifting Crate must be lifted high enough to clear a hand rail on the equipment. The slings for lifting the Lifting Crate must not be exceed 60°. The Lifting Crate can only be lifted by the crane to a maximum height due to the ceiling height.

Finite Element Analysis

As can be seen in the figures, the Lifting Crate is lifting exclusively by one lifting sling/chain on each side of the crate (i.e., one sling is strung through both loops on one side of the Lifting Crate). In order for there to be sufficient clearance between the bottom of the Lifting Crate and the handrail on the top level of the equipment the Lifting Crate is being lifted onto and the maximum lifting point of the crane while not exceeding the maximum angle of 60° stipulated by the manufacturers of the sling, the steel loops needed to be moved and enlarged. The loops will be positioned 35 mm from the edge of the crate and enlarged to 120 mm ID such that the chain hooks can pass through [1-3].

The purpose of this report is to certify that moving and enlarging of the loops will not make the Lifting Crate design uncompliant with the relevant Australian Standards (Figures 1-3).

The lift capacity is 1000 kg and the weight of the Lifting Crate is 175 kg for a total lift requirement of 1175 kg. AS4100 stipulates that a proof load of twice the working load limit is required for rated capacity up to 10T. As such the modelled load is 2350 kg. As slings are used, the 4 lifting points are used so the vertical lift component on each loop is 587.5 kg [4,5].

The Lifting Crate was simplified to one side as lifting is done only on the hoops shown. The red outlined area was modelled as fixed. The load is shown as yellow arrows. The load applied in the FEA is at 60° so the inward horizontal force at each loop is 339 kg. The resultant force at 60° is therefore 678 kg (Figure 4).

Figure 1: Lifting Crate complete with lifting slings.

Figure 2: Lifting sling instructions plate.

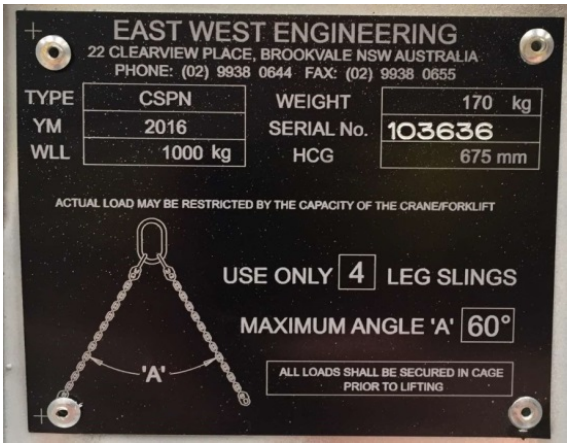

Figure 3: Lifting Crate instructions.

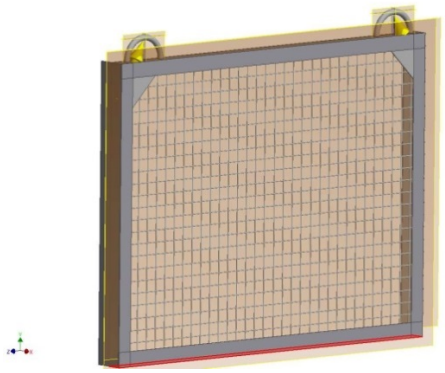

Figure 4: Lifting Crate FEA model complete with fixed area and loads.

As per the figure below, the maximum stress in the Lifting Crate is 157.8 MPa. As per AS3990, the maximum stress shall be 0.66 × material yield. The material yield is 320 MPa so the maximum allowable is 211.2 MPa. The design therefore satisfies AS3990 and AS4991 (Figure 5).

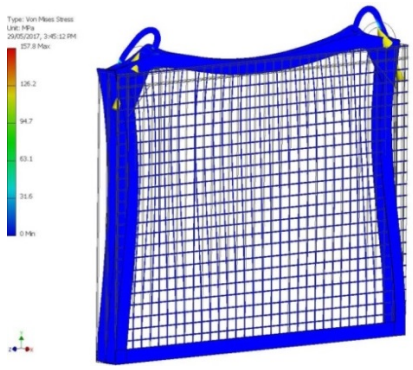

Figure 5: Maximum stress shown in the Lifting Crate.

Conclusion

This article provides a summary of the design and operating parameters for the Lifting Crate. Finite element analysis via Autodesk Inventor was used to determine the structural stresses induced by the forces. A 2350 kg load has been nominated for design purposes in order to satisfy a working load limit of 1000 kg through Australian Standard AS4991 Lifting Devices and AS3990 Mechanical Equipment – Steelwork. The standards have been utilized for determining the suitability of the design. The design meets the requirements of the standards for the proposed loads.

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