

Letters to the Editor

The Author Response: A Case Study on Engineering Failure Analysis of Link Chain



The authors thank Dr Yu for his interest in our findings on engineering failure analysis of link chains [1] and his valuable criticism of our findings [2]. We respond to his comments as follows, focusing on the content of the question (Figs. 1 and 2).

1. Response revised on FEA category in this paper: This article is written for supplementation of stress analysis parts (relatively idealised and straightforward structure, simplifying the loads and material property assumptions, etc.) for crane chain in the existing paper [1]. In material properties, an elastic material model for stress analysis, which was conducted in an existing paper, was used to re-evaluate plastic collapse due to the Working Load Limit (WLL) in each installation condition. The analysis results show that high stress (total stress) at the junction of the barrel and that of curvature of the crane chain are similar in the area where the crane chain was broken. Compared with the correct installation conditions, when high stress is applied, the incorrect installation condition evinced a breakage. For determining the membrane and bending stress components, the total stress distribution was obtained from elastic stress analysis, and linearised on stress component integrated along the cross-section of Stress Classification Lines (SCLs) through

the crane chain's wall thickness. It is shown that the results of this analysis support the results of the fractographic analysis presented in the original paper.

2. Additional explanation of the fractographic analysis: According to your comments on the paper, you claim that “the crack likely initiated around the chain inner surface, where the presence of high tensile stress under tension load or small stresses under bending load while a ‘crushed damage’ area was found there.” However, the crushed damage observed in the chain's inner surface cannot be formed by uniaxial tension load because the inner surface of the chain at this position was not contacted with other chains on the condition that the crane chain was installed correctly, as shown in Fig. 7 [1] A in the paper. Accordingly, we concluded that the crushed damage was possibly formed by an improperly installed crane chain inducing abnormal interlocking of the chains (Fig. 3).

Also, the step-like topographies observed in the fracture surface in Fig. 4B [1] and 5C [1] is the unique morphology not usually identified in tensile overload fracture surface [3]. Under uniaxial tension load conditions, the fracture surface shows the equiaxed dimples in the flat surface and the elongated dimples in the in-

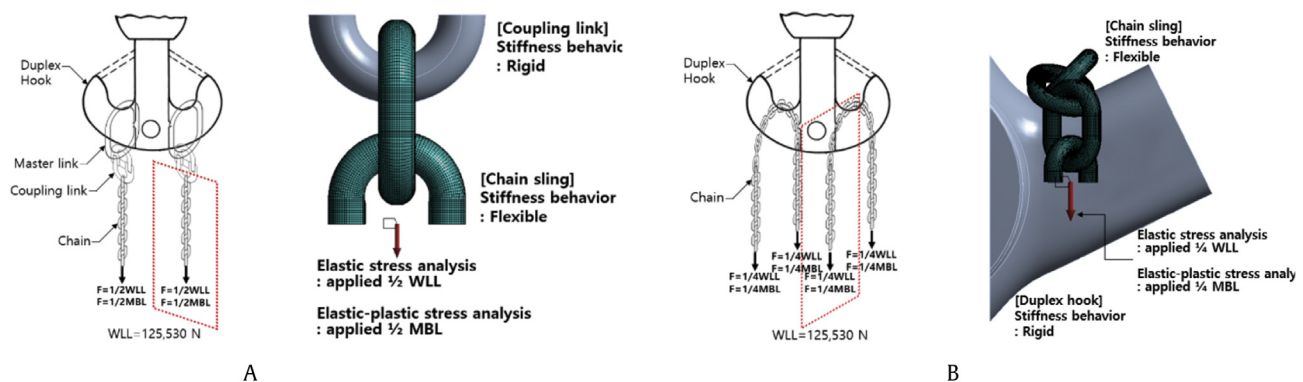


Fig. 1. Boundary and loading conditions of elastic stress analysis in each installation condition. (A) Correct installation condition. (B) Incorrect installation condition.

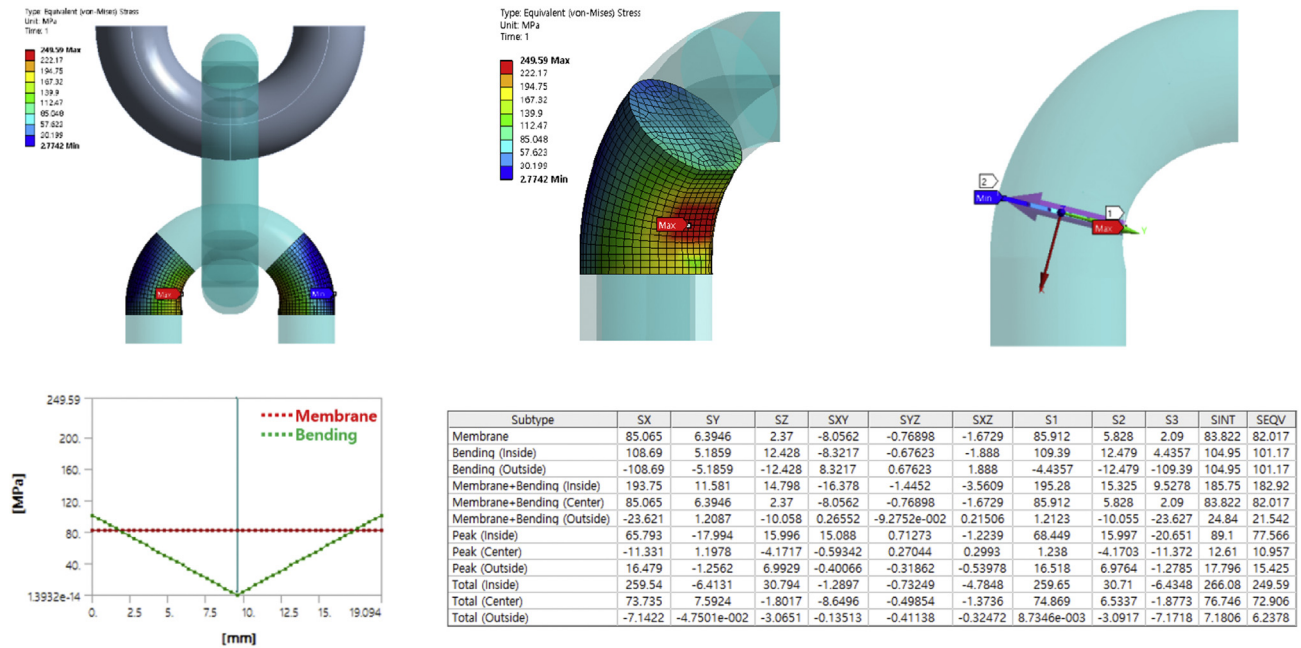


Fig. 2. Results of elastic stress analysis of correct installation condition.

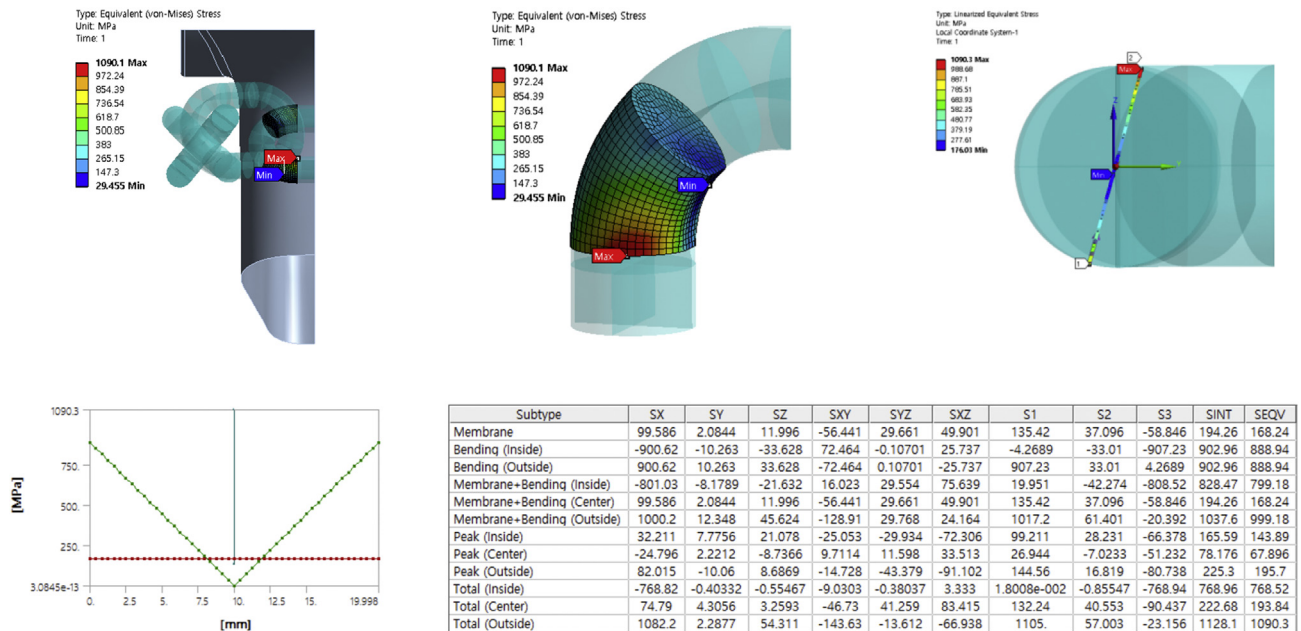


Fig. 3. Results of elastic stress analysis of incorrect installation condition.

clined region having the cup and cone shape. For this reason, it is concluded that the shear fracture consisting of elongated dimples and step-like topographies may be usually formed by bending or shear overload rather than uniaxial load condition [4] and the width reduction of the link chain and the crushed damage formed by the compressive load on the side of the link chain were considered as the pieces of evidence of bending load rather than uniaxial tension load. Therefore, we concluded that the left side of the link chain was fractured in advance by bending load due to improper installation, and later the right side of the link chain was fractured due to uniaxial load beyond the material strength after failing the left side of the chain.

Conflicts of interest

The authors declare no conflict of interest.

References

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