

Crack Failure Analysis of Scaffolding Frame Intersection using ADINA

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ABSTRACT

This paper describes the analysis of scaffold frame intersection joint crack. Independent scaffolding type is selected and analyzed for the cracks and deformations. The modelling of the structure is done with the Solid works software and the rendered model was imported to ADINA structures software. All the dimensions for the scaffold design were followed as specified in the standard codes BS4945. Live loads of 2kN/sq.m were taken. The post processing is executed and the results were generated. The results show that maximum bending moment 11.94N-m is at intersection joints particularly at joints. The minimum bending moment -13.44N-m has occurred below the junction the effective stress calculated around the junction of the scaffold is 3.493N/mm² and the deformation of the scaffolding frame is at intersection joints and the cracks are formed. Visualizing the crack by using ADINA may be the best way to estimate the deformation modes and crack. This will definitely be useful for the remedial measures to prevent cracks in a scaffold structure.

Keywords: ADINA Structures, crack visualizing, Crack failure analysis, independent scaffold type, Deformation of Scaffold.

INTRODUCTION

Scaffolding is used on new building projects, and for existing structure including maintenance, repair and painting work. The temporary structure needs to be structurally safe yet also capable of rapid erection, disassembly and reuse. Scaffolds are temporary structures commonly used in construction to support various types of loads¹². In Building construction some form of temporary support is required to provide a safe and convenient working area above ground level⁸. The main elements of scaffolding are standards, ledgers, transoms, base plate, base jack and diagonal bracings⁸. Figure 1 represents the main element of the scaffolding structure. The scaffolding failure occurs due to crack/collapse due to excess load, poor

design of the scaffolding structure¹⁰. Generally steel tubular scaffoldings are used due to the high strength, durability as well they can be reused the diameter of the tubular steel used as ledgers and standards vary from 42mm to 48mm with the approximate thickness of 3mm^{12, 13, 14}. Scaffolding for the single storey double bay scaffolds with boundary conditions, joints are assumed as rigid were reported¹. The objective of this paper is to describe the analysis of scaffold frame intersection joint crack for independent scaffolding using ADINA structures software.

EXPERIMENTAL

Modelling of scaffold frame

The scaffold model is created for G+1 residential building using Solid works software.

Scaffold frame sections are designed for the 6 m x 8 m side wall. Selected model was independent scaffolding frame system. Table 1 describes the dimension of the scaffolding frame. After completing the scaffolding model the section are saved as the parasolid (X_t) model type. Figure 2 represents the independent scaffold model for G+1 residential building using solid works software. The output scaffold model is imported to the ADINA structures software. Figure 3 represents the imported model of independent scaffold section from solid works to ADINA structures.

Design Procedure

The following design principles are used in creating the model and analyzing the scaffold frame intersection

Table 1: Design Parameters and specifications used

Parameters	Specifications
Pipe Diameter	48 mm
Pipe Thickness	4 mm
Lift Height	2 m
Scaffold Width	3 m

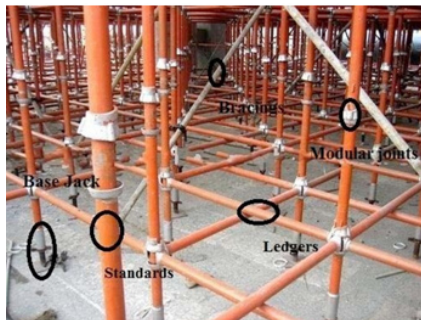


Fig. 1: Scaffolding Main Elements

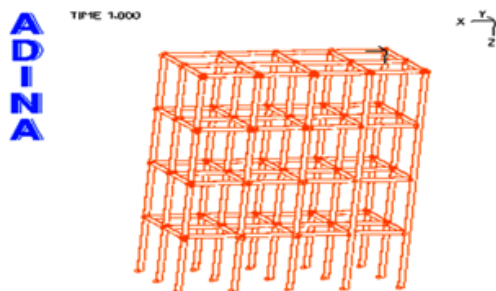


Fig. 3: Imported model in ADINA structures

- Defining Model Geometry
- Specifying Boundary conditions
- Applying loads and material properties
- Meshing
- Post-processing

Defining model geometry

The model geometry already done with the help of solid works is imported to ADINA structures. The Import model is saved in the parasolid format and the analysis are done for the intersection and joints. Figure 4 represents the intersection member of the scaffold frame. Figure 5 shows the scaffold frame intersection joints.

Specifying Boundary conditions

The boundary conditions are given through the fixity icon. It is used to fix some or all degrees of freedom on certain parts of model to geometric entities or sets of nodes, element faces/edges.

Applying Loads and Material Properties

Load conditions are applied using load icon. Live loads of 2kN/sq.m were taken. Load acting on the scaffold frame intersection members are generally considered as distributed load and in scaffold frame intersection joints it is considered as

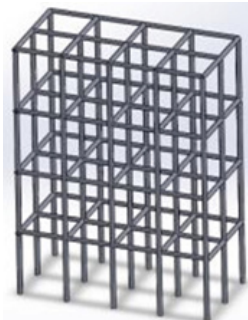


Fig. 2: Scaffold Design using Solid works

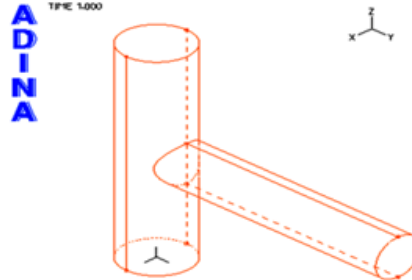


Fig. 4: Scaffold frame intersection member

point load. Figure 6 shows the load acting on the ledgers (ie) the horizontal member of the scaffold frame. For scaffold frame joints load are considered as the same value given on the scaffold frame member. After applying the load we can visualize the cracks formed between the junctions of the scaffolding frame. Figure 7 evidently shows the load acting on the joints of the intersection frame and also the crack formed. Young's modulus $2.07E11$ and the Poisson's ratio 0.29 are taken as common

material properties for both the intersection frames and intersection joints frame sections.

Meshing

Meshing is performed to generate finite elements on geometry in the model. Figure 8 represents the mesh created on the surface of scaffold intersection member. For cracks which are formed inside the scaffold frame junction also meshing group elements are created. Figure 9 represents the mesh created on the crack surface. Figure 10 shows the meshing group elements created for the scaffold frame joints.

RESULTS and DISCUSSIONS

Post-processing method helps in getting the results. The output model (.por) file is open with the help of post-processing AUI database. The concentration of bending moment at intersection particularly joints are getting higher value. From figure 11 and graph red colour indicates higher bending moment. The graphics window show the

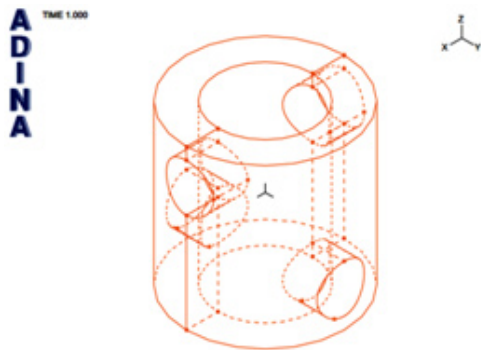


Fig. 5: Scaffold frame intersection joint

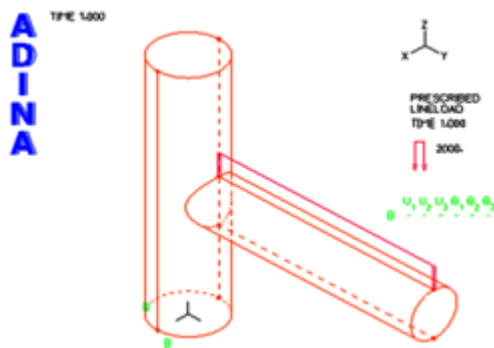


Fig. 6: Load acting on the scaffold frame member

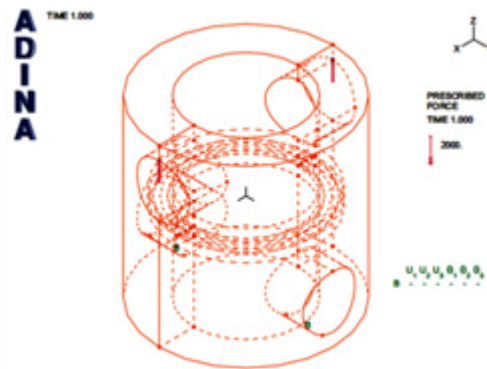


Fig. 7: Load acting on the scaffold frame joint

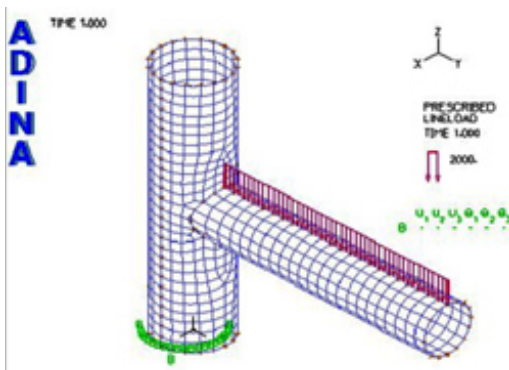


Fig. 8: Mesh created on the scaffold frame

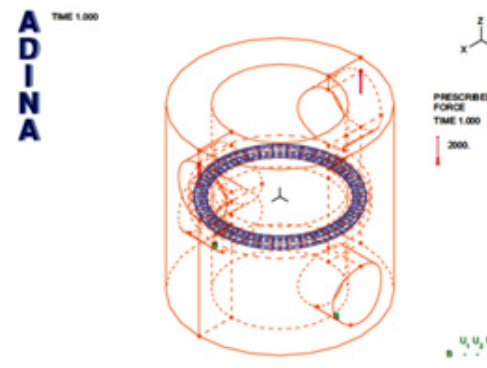


Fig. 9: Mesh created on the crack surface of scaffold frame

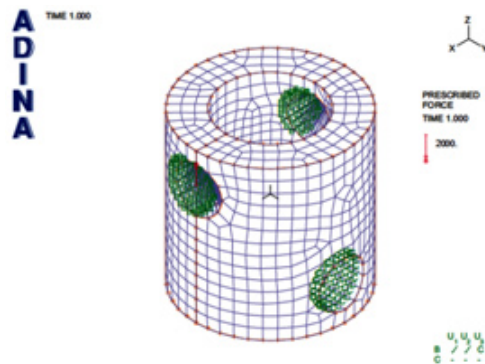


Fig. 10: Mesh applied on the scaffold frame joints

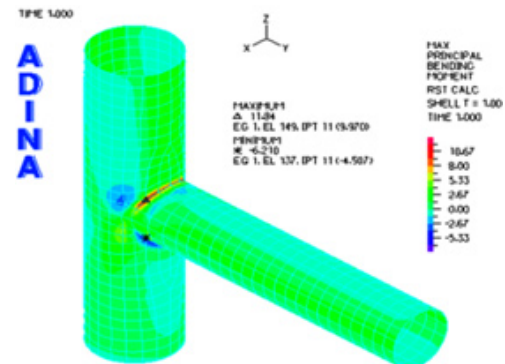


Fig. 11: Max Bending moment on the scaffold frame intersection

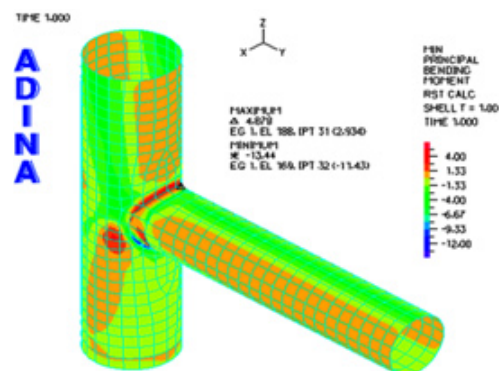


Fig. 12: Minimum Bending moment of the scaffold frame

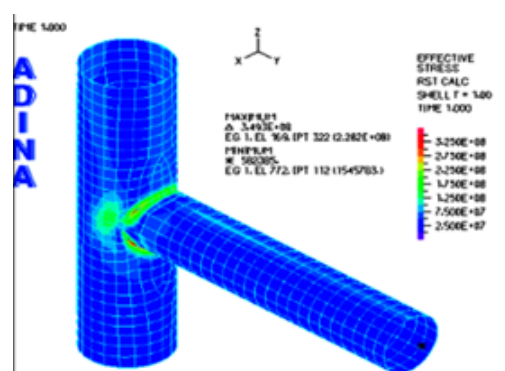


Fig. 13: Effective stress of the scaffold frame

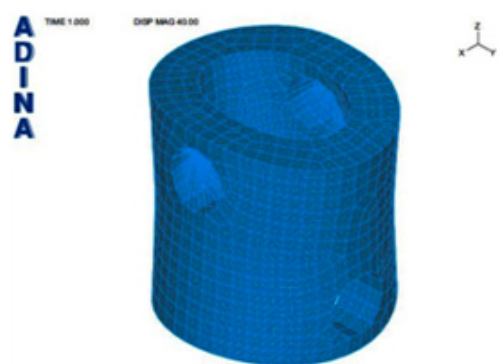


Fig. 14: Deformed shape scaffold intersection joints

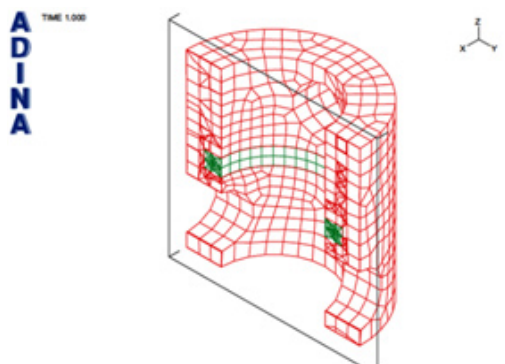


Fig. 15: Colour variation represents crack on scaffold frame

maximum bending moment as 11.94 N-m. From figure 12 and the graph, blue colour represents minimum bending moment has occurred below the junction. The graphics window shows the minimum bending moment is -13.44 N-m. The graphics window and figure 13 shows the maximum effective stress as 3.493 N/mm² which is calculated around

the junction of the scaffold frame. Figure 14 shows that deformations take place due to applied load and the round shape scaffold gets deformed. After deformation it is similar to oval shape and deformation of the scaffold frame is at intersection joints. Figure 15 shows the difference between the crack and scaffold frame structure joints. Cross

sectional views can clearly make understand the crack formation inside the structure. The colour variation also helps to understand the purpose. This shows the exact crack design can be visualized in the ADINA structures.

CONCLUSION

This paper using ADINA structures shows that the crack could possibly occur in the joints of scaffolding. Using ADINA structures estimation of deformation modes can be done with accuracy. All

the stresses, strains and other calculations can also be computed and analyzed. Visualizing cracks will definitely be useful for the remedial measures to prevent cracks in a scaffold structure.

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