Robots and adhesives – design with safety

A study that explores the mystical world of adhesives by looking at a vital joint in an industrial robotic wrist.

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With industry 4.0 just around the corner, there is an increasing demand for robots that can execute complicated tasks for a near-infinite time. This raises the awareness for effective development of industrial robots in terms of performance, quality, and cost.

Creating the best robots in the world is not an easy task. Swedish manufacturers has been on the forefront of industrial robot innovation in many decades, but there is still a pursuit for progression. Due to the excessive use of their robots in both new and familiar industries, sometimes it leads to abnormal movements and stresses on the structure. As a result, there has been cases where glued and bolted joints in vital locations on the robot tend to fail. A frequently problematic area is the robot's wrist seen in the figure to the right.

This study was about finding the root to the problem. By analysing how similar joints are being modeled and evaluated elsewhere, a comparative analysis and review was done on the application model. As an additional part of the study, millions of potential movements of the robot were simulated with the goal of finding the worst possible cycle for the robotic wrist.

A crucial criteria in simulations is the time spent on the model. Since adhesives are an extremely complex phenomena, this puts a lot of pressure on the chosen modeling method.

Thus, the results of the study were highly satisfying. After dozens of various adhesive modeling methods and hundreds of iterations, the whole design process could be simplified into replacing the adhesive layer with a frictional contact surface with a modified friction coefficient.

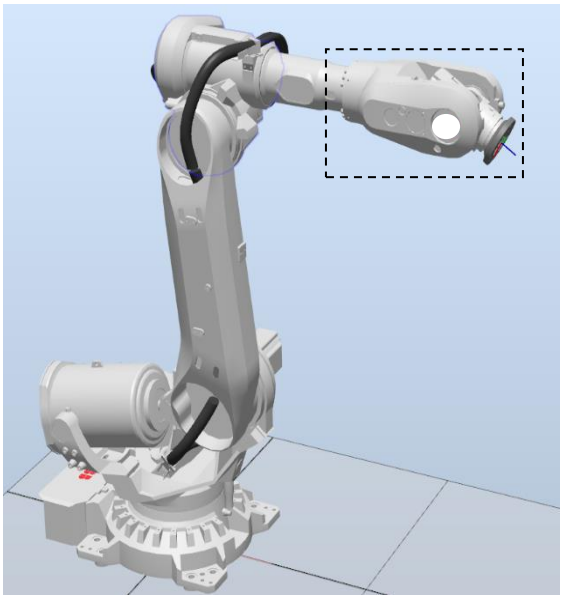

Figure: The industrial robot that was subjected to the study, see the wrist and joint in the dashed box.

The main cause of failure was determined to be due to an insufficient contact pressure between the two surfaces that are being interlinked. It may not sound as much to the world, but in terms of time savings and a reduced risk of failure it is considered as a major accomplishment.

Furthermore, a new method of finding the worst set of combinations that the robot can execute was established, leading to a better understanding of unexpected movements that arise in production situations.

The study culminated in a design framework for future applications, where robots that have joints of this character can now be designed in a more efficient and a safe way. The full methodology, model, and the rest of the study is published in the report "Finite Element Modeling of Glued Bolt Joints" at the Faculty of Engineering – LTH – at Lund University.