Development of crane for 3-D printing in construction

A crane which will be used for 3-D printing of buildings, was developed. The crane design was created using beams from the workshop at IKDC, and will be able to carry an extruder while moving in several directions.

3-D printing, or additive manufacturing, which is the main method behind 3-D printing, has become more popular in recent years. Printers are becoming cheaper and more available for the public, and the benefits of 3-D printing are recognised in many industries. However, these methods have been limited to printing with plastic materials, due to their manipulability which makes this family of materials well suited for additive manufacturing. But recently there has been an interest in applying 3-D printing in construction and some companies have already developed extruders and printed their first buildings.

The Department of Product Development at Lund University are interested in creating their own 3-D printer which prints houses. A cement extruder already exists and the department wants to build a crane to carry the extruder. A design for the crane was proposed using two beams from the workshop at IKDC, LTH campus. These beams would have to be modified in order to suit the requirements put on the crane. It had to be able to move in both the vertical and horizontal direction, while also being able to rotate around its vertical axis. Rotary motion was achieved by mounting a motor at the top of the vertical beam. Power was transferred from the motor, to an axis, through a toothed belt. The axis was in turn connected to the second beam, which was placed horizontally. By fitting the horizontal beam with racks, a small robot is able to traverse on these racks, thus enabling horizontal movement.

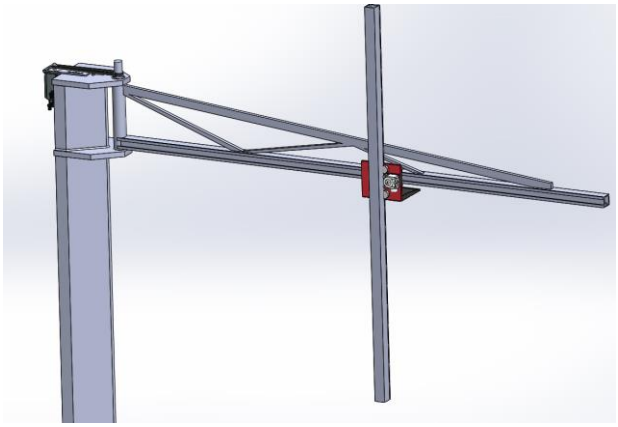

Figure 1 3D CAD model of the whole crane.

The last specification required movement in the vertical direction too. This was achieved by cutting the horizontal beam in two and placing the second half so that it crosses the first. Since both parts have racks, the second part can move in the vertical direction by attaching a motor on the horizontal beam. The motor is placed on the same robot which traverser on the horizontal beam. Shown in the figure to the left, is a 3D model of the whole crane which shows how the different parts are assembled. It can be seen that the horizontal beam is reinforced with additional bars. These will help carry the load and ease the stress which occurs inside the weld between the axis and the beam. The robot is the red “L-shaped” plate in the figure.

Complete calculations for the dimensioning of the transmission belt and bearings, which were placed between axis and the vertical beam, are done in this work. Calculations were also done from a structural point of view to identify stresses and deformations in the crane during operation. These were completed using both analytical methods, derived from basic solid mechanics, and simulations, using the finite element method.

The results obtained in this work are used to propose a design for the construction of a crane from the parts in the workshop. Suggestions on modifications and which additional parts to buy, such as the bearings and transmission, are also presented.

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