American University of Armenia

AKIAN COLLEGE of SCIENCE & ENGINEERING

Design of a Beam Load Cell for a Given Strain Gage Sensor (poster 1)

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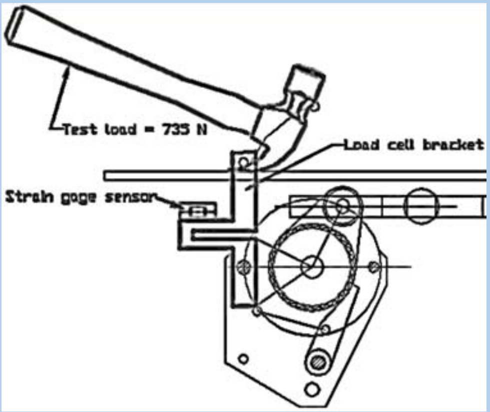
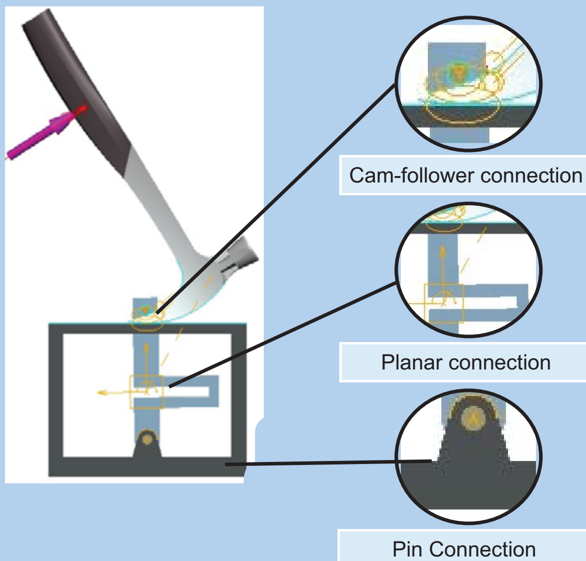
Software: Pro/ENGINEER, Pro/MECHANICA Year:2006



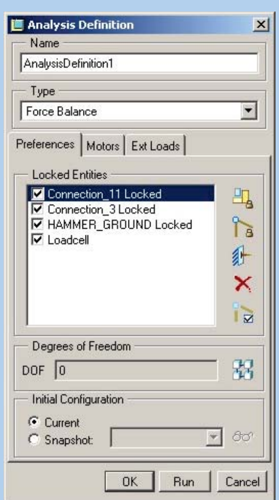
Introduction

Industrial Technologies Co. (ITC) provides testing services to a number of international hand tool manufacturers. Among these services is the Nail Pulling Test, which controls the nail-pulling ability of a claw hammer. The drawing at left describes how the physical tests are done at ITC. The nail pulling forces resulting from the test loads on the handle of the hammer are measured through a standard strain gage sensor attached to the load cell bracket. For ITC, it was a problem to find the shape of the load cell bracket that would result in acceptable deformations during the tests: sensor strains were generally too small to provide reliable information about pulling forces. They tried to solve this problem by trial and error - changing different dimensions and machining a new bracket each time. This turned out to be a time-consuming and costly approach. In this project the problem is solved using modern computer-aided engineering tools.



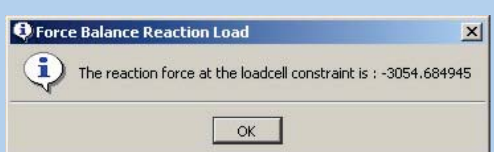
Mechanism Design

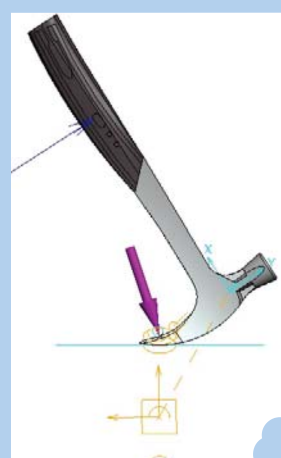
In order to simulate the test and obtain the required information we need to create 3D models of the parts and combine them in an assembly (the left picture). The Mechanism Design module enables us to calculate forces occurring in the bracket under applied loads. In order to retrieve this information we replaced the real connections in the model with Pro/ENGINEER idealization features: 2 cam follower connections designate the contact regions between the lower surface of the hammer head and the base plate on the one hand, and the upper surface of the hammer head and the pin on the another; the pin connection designate the joint between the bracket and the base; and the planar connection restricts the motion of the hammer to a planar. We also applied the test load on the handle.



Force Balance Analysis

The goal of the analysis done in the Mechanism Design module is to find the force exerted on the bracket. In a Force Balance analysis, we define the static configuration of a system, and the analysis returns the needed reaction force. The magenta arrow shows the vector of the force. Its value is shown in the information window below. With this force the pin acts on the hammer. It is not difficult to presume that the pin acts on the bracket with the equilibrant to the found force.





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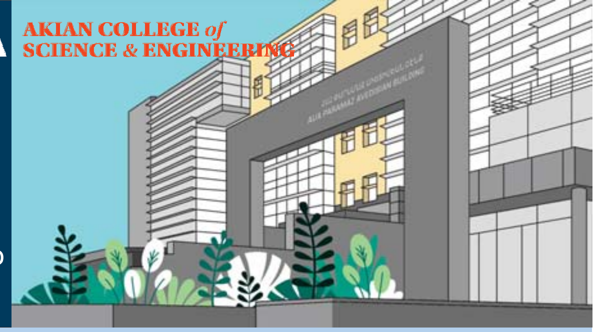

Design of a Beam Load Cell for a Given Strain Gage Sensor (poster 2)

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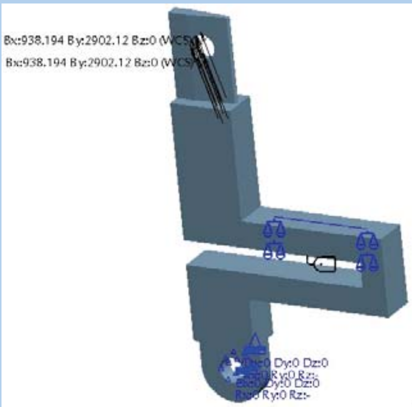
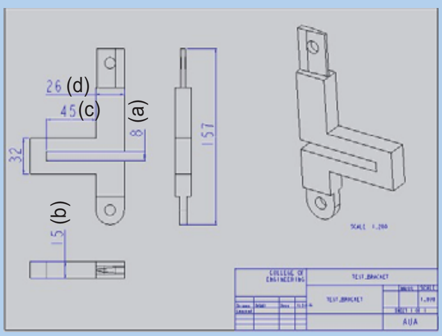
Software: Pro/ENGINEER, Pro/MECHANICA Year:2006



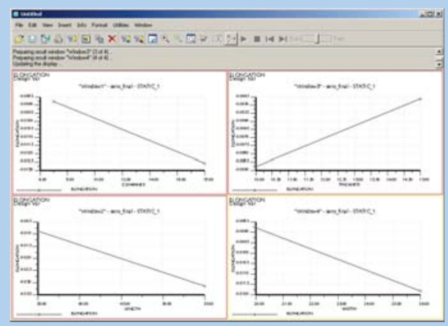
Static Analysis in Pro/MECHANICA

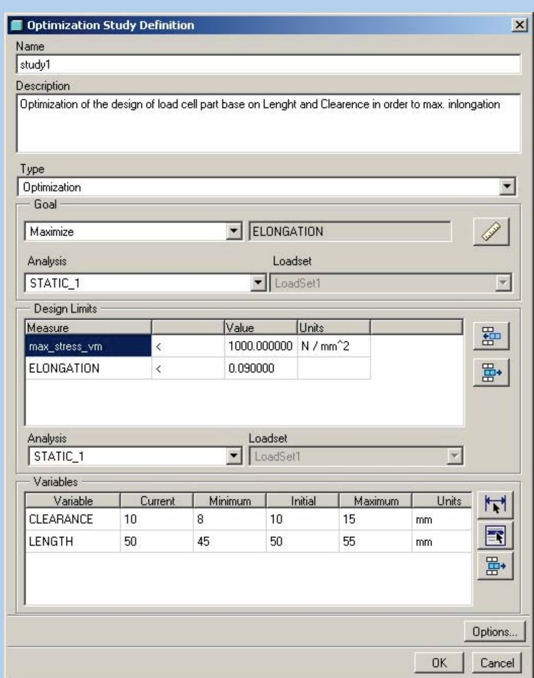
In the Structure module of Pro/MECHANICA we define the constraints and loads applied on the bracket, specify the material, and assign some measures that are used to calculate the elongation of the strain gage sensor represented as a blue line on the left picture. Four scale symbols are for endpoint displacements in X and Y directions. Since Pro/MECHANICA can calculate the displacement of a point, we can then input a formula to calculate the elongation.



Sensitivity Analysis

Now that we are able to calculate the elongation we should decide what will be the design variables, the modification of which can give us the desired result. This is done by a Sensitivity Analysis. We selected the following parameters with the given ranges: a - clearance (6 - 18 mm); b - thickness (10 - 15 mm); c - length (35 - 55 mm); d - width (20 - 26 mm). The analysis showed that only length and clearance have influence on elongation value (see the graphs on the right).





Optimization Analysis

The Optimization Analysis results in the optimal shape of the bracket that should satisfy our requirements related to the strength of the part and the elongation of the attached sensor. The picture on the left shows how these requirements have been specified. The picture below shows the displacement and stress diagrams for the optimized part.