True-Load Software and ANSYS Workbench Solve Difficult Strain Challenges

The True-Load software from Wolf Star Technologies performs load reconstruction using the well-established principle known as influence coefficients. In short, True-Load uses strain measurements and a correlation matrix extracted from the FEA model to reconstruct operating loads on structures. The True-Load software automatically optimizes the strain gauge placement and pre-conditions unit load cases supplied by the FEA analyst. This allows the user to turn any component into a multi-DOF load transducer by simply attaching uniaxial strain gauges at the optimized locations from True-Load.

True-Load operates on the principle of influence coefficients. This takes advantage of the proportionality between loads and strains; strains and displacement; and strains and loads. The influence coefficient technique essentially constructs a strain corollary to Hooke's law. This concept can be shown in the following figure.

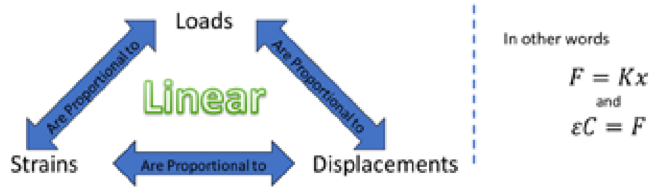

Figure 1 - Linear Load Model

True-Load takes advantage of this principle by constructing a correlation matrix (C) from optimal strain gauge placement on the FEA model. The user supplies a series of unit load cases that will define the loading DOF sensitivity for the part. Any loading that can be conceived of in FEA is fair game for True-Load. The strain gauges will be placed in nominal locations on the model – staying away from stress concentrations due to welds, notches, areas of contact, bolted joints, pins, etc. The key for this technique to work is for the gross mechanical characteristics of part to obey Hooke's law. Local plasticity and nonlinearity is acceptable as long as these effects do not dominate the component's response. Once the strain gauges are placed, True-Load calculates the loading from measured strains via the following equation.

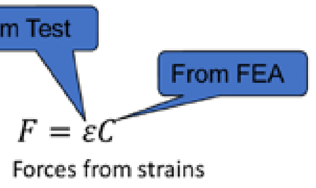

Figure 2 - Governing Equation for Influence Coefficients

The correlation is typically 5% error in strain or less. Once the process is optimized for a component, error is often expected to be less than 2%. Even though the underlying mathematics are linear, True-Load often predicts highly nonlinear effects. For instance, contact loading and nonlinear loading from elastomers are regularly captured. A nonlinear FEA analysis is basically a piecewise linear

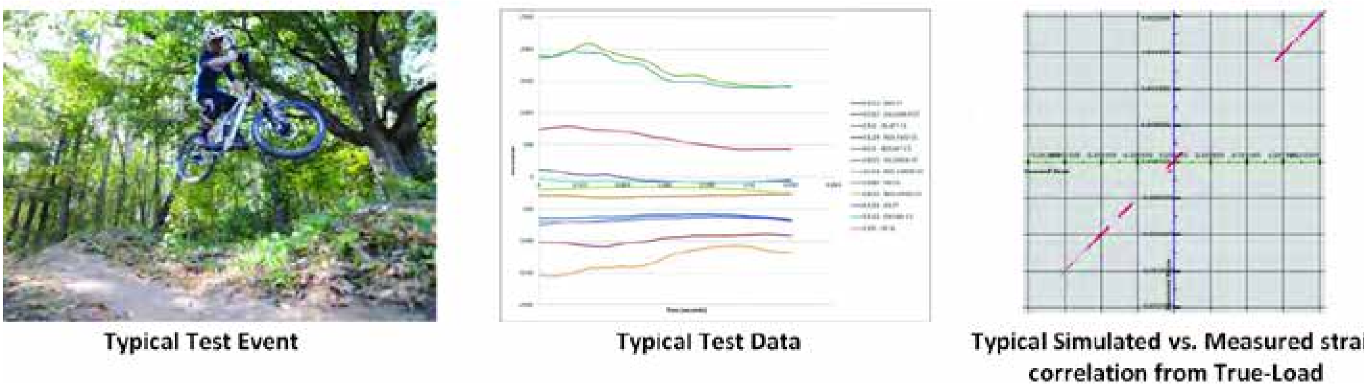

Figure 3 - Trek True-Load Application

solution. True-Load takes into account the piecewise linear mathematics in a different order through the user's unit load cases. Essentially, True-Load is letting the strain gauges act as the world's most powerful supercomputer to dictate the FEA response of each unit load in the model. Here are few published examples from our customers. The first is from Jay Maas at Trek bicycles. Trek uses True-Load to understand complex loading on their frames. Jay wrote in 2015 about how they could capture the severe loading that occurs during jumps using their traditional method. These tests together with True-Load gave Trek a better picture of the severe loading occurring in the proving ground jumps. The loading calculated by True-Load is completely different from the traditional loading used in Trek's laboratory environment. This allowed Trek to improve their designs and testing methods to capture the effects of real-world loading (Fig. 3).

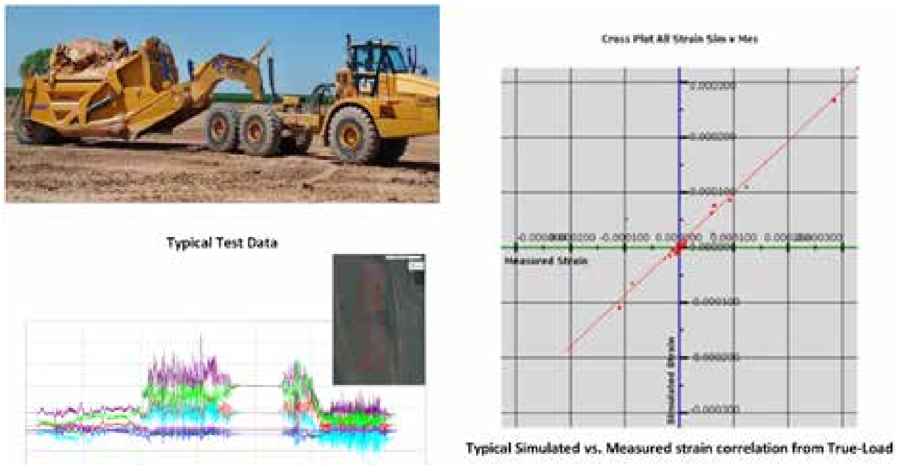

Figure 4 - K-Tec Earth Movers Application

In Figure 4 there is a K-Tech earth mover from a paper presented by Wayne Tanner and Cynde Murphy of Adaptive Corporation. In this project the operating loads on the earth mover are calculated. An interesting result of the study showed that the most severe loading on the earthmover occurs in transit and not during digging operations. This was totally counterintuitive to the engineers at K-Tech. The figures show typical plots from True-Load: the time histories of strain from the measured testing together with a cross plot, shows the measured strain on the horizontal axis and the simulated strain using the True-Load forces on the FEA model on the vertical axis. A 45 degree line shows perfect correlation.

Now, with the integration of True-Load into ANSYS Workbench through a new interface, using True-Load is extremely intuitive for ANSYS Workbench users. All the components of the True-Load environment are exposed directly to the Workbench environment, and can be included in ANSYS simulations. This gives product developers increased power and flexibility in designing vehicles that can withstand the strains they will experience in everyday use.

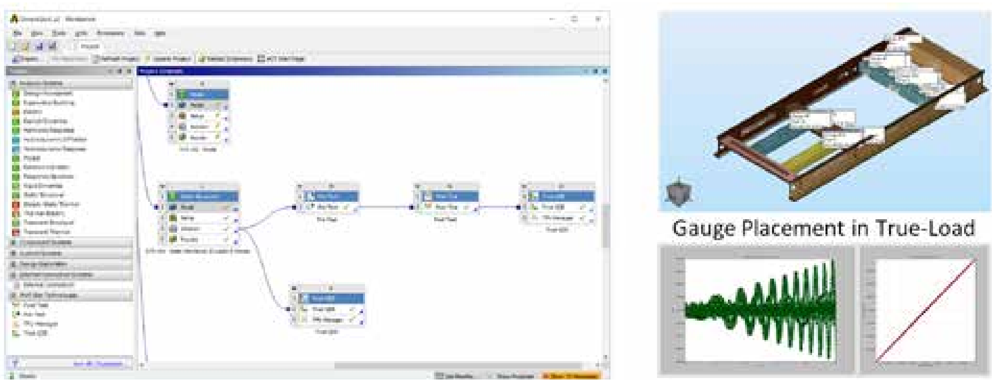

Figure 5 - ANSYS WorkBench True-Load Integration

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