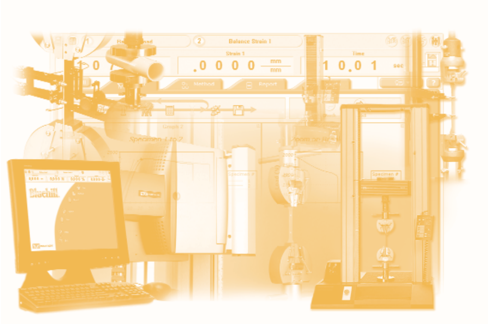

Reduction of Inertial Effects Resulting from High-Speed, Low-Force Testing

Application Report

Introduction

There are two common challenges in conducting high-speed, low-force testing. The first challenge is overcoming the inertial force resulting from acceleration of the upper grip and the crosshead. The second challenge is to reduce the amplitude of the resonant frequency resulting from the combination of a high rate of crosshead extension and the grips and load cell used. The frequency of these oscillations is a function of the system, but may become less evident if the amplitude is decreased. In both of these challenges, by reducing the mass of the grip attached to the load cell, the amplitude of the inertial force and the oscillations will decrease. The purpose of this testing was to isolate these two challenges and then provide a solution for minimizing their effects in future testing.

Test Configuration

In order to most accurately isolate these effects and recommend a solution, the first test was designed to replicate the challenges associated with high-speed, low-force testing. A 5564 universal testing system with a 500 N load cell mounted at the crosshead was configured with 1 kN pneumatic side action grips. No specimen was loaded into the grips; only load data was collected to isolate the noise in the load signal as a result of crosshead acceleration and speed.

The next four tests were designed to minimize the effects by moving the position of the load cell from the crosshead to the base of the test frame and by reducing the mass of the grips attached to the load cell. In all tests, data was collected at 1pt /6 msecs and the rate of crosshead extension was set to 40 in/min.

A summary of the methodology used in these tests is described in Table 1.

Specimen #	Load Cell and Position	Grips
1	500 N at crosshead	1 kN pneumatic side action
2	500 N at base	1 kN pneumatic side action
3	10 N at base	1 kN pneumatic side action
4	10 N at base	250 N pneumatic side action
5	10 N at base	5 N pneumatic side action

Table 1:
Methodology for investigating the effects of inertia on test results.

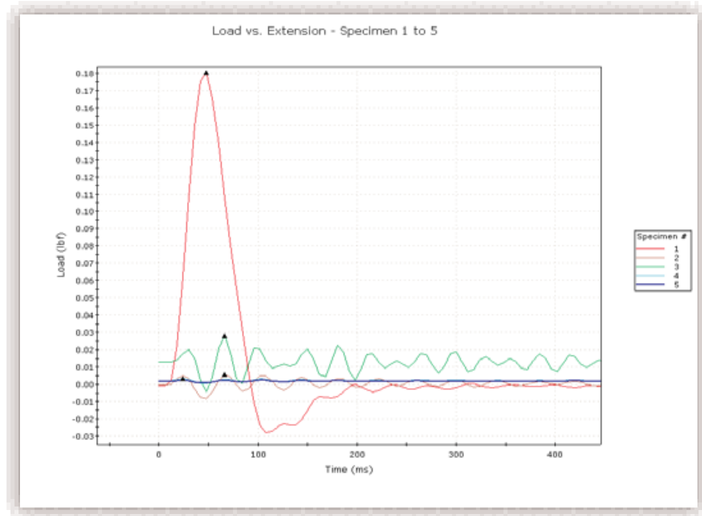

Figure 1:
Load vs. time data for five different test configurations.

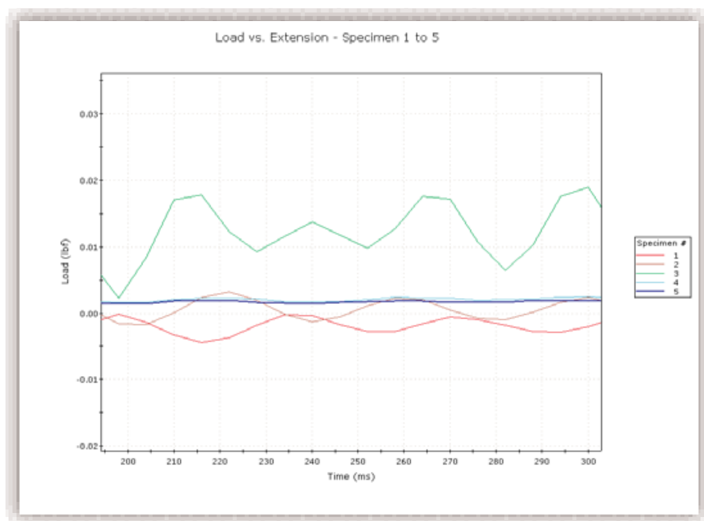

Figure 2:
Close-up view of load vs. time data for five different test configurations.

Conclusions and Recommendations

Specimen #1 was intended to simulate the challenges associated with testing at high speed and low force. The inertial force required to accelerate the crosshead, load cell and upper grip causes a large initial peak load. The frequency and amplitude of the oscillations that follow are a function of the test frame, load cell and upper grip mass moving at a speed of 40 in/min.

In specimen #2 (and the remaining tests), the load cell was moved from the crosshead to the base of the test frame. In comparison of these results with specimen #1, the inertial effects from the acceleration of the crosshead and grips are significantly reduced resulting in a large initial peak load reduction.

In specimens #3 through #5, the 500 N load cell was replaced with a 10 N load cell to explore the affect of load cell accuracy on the readings. Specimen #3 shows that the 1 kN grips may be too heavy for the small load cell because of an increase in the amplitude of the oscillation frequency. The 250 N and 5 N pneumatic grips show a significant decrease in the amplitude of these oscillations.

In conclusion, the above discussion and test results demonstrate a reduction in the effects usually resulting from high speed low force testing applications. Based on this information, it would be recommended that a base mounted load cell or dual test space be used in future applications to reduce inertial effects. It would also be recommend that a low mass grip, such as the 250 N or 5 N pneumatic grips be selected to minimize the resonant frequency amplitude.

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