# PRODUCT DESIGN DOCUMENT

25P01 MORSE KEY

EXPERIMENTAL DESIGN VALIDATION


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## 1 Summary


This document describes the experimental procedure used to validate the design of a simple flexure hinge Morse key.

Testing demonstrated a measured stiffness of 0.37N/mm, within 5.1% of the analytical prediction. Given the known limitations of the prediction methods, this is considered to validate the design approach for the flexure hinge.


## 2 Objectives

The aim of the work was to examine the basic force-displacement characteristic of the key under static load, ultimately allowing for comparison of measured key stiffness with analytical predictions.

## 3 Equipment

Ideally, the Morse key would be mechanically characterised with a servohydraulic load frame, allowing for the controlled application of target force and measurement of the corresponding resultant displacement, or vice versa. However, without access to dedicated mechanical testing equipment, an improvised test rig was constructed using a 3D printer, digital kitchen scales, and a fastener of known pitch.

The test rig shown in Figure 1 consists of a 3D printed gantry frame with an M12x1.75 fastener serving as a vertical lead screw. As the screw is rotated, it compresses the Morse key, which is located on inexpensive digital scales. Displacement is calculated from the screw's thread pitch and angular displacement, while the scales measure the resulting force response. This arrangement allows for rough force-displacement characterisation without specialised equipment

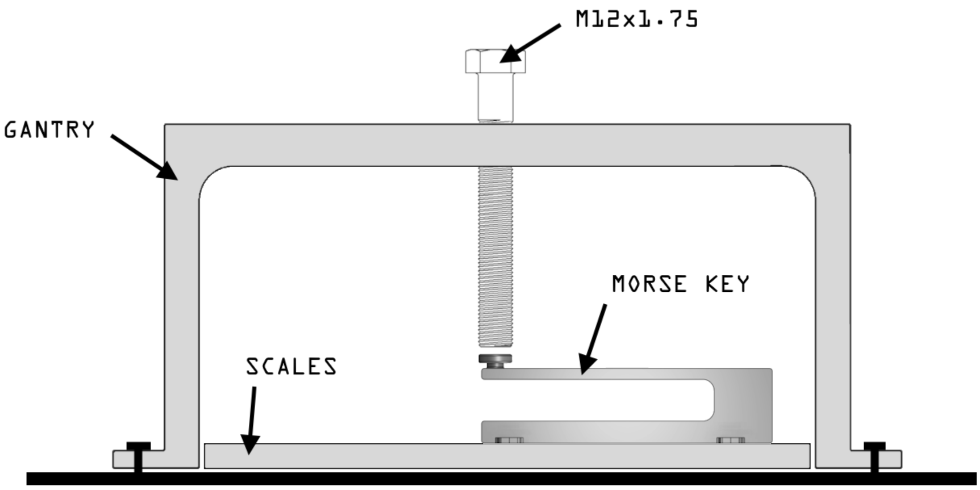


Figure 1: Gantry Rig Arrangement

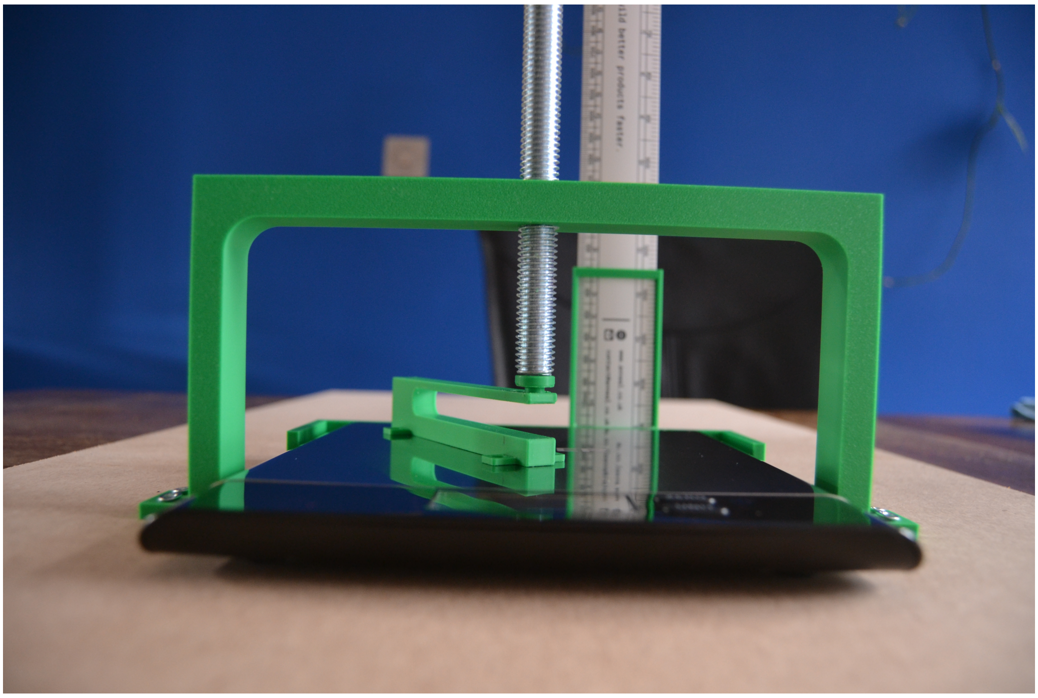

Figure 2: Gantry Rig Arrangement, Assembled

# 4 Method

The experimental procedure adopted was as follows:

1. The Morse key was positioned under the gantry and the scales were zeroed.
2. The lead screw was advanced until initial contact with the key was confirmed by a low magnitude reading on the scales; around 1-2g.
3. The screw was backed off until the scales returned to 0g indicated, and the screw head was marked in the 'zero position' with a permanent marker.
4. The screw was then rotated in 180° increments, with force readings recorded at each step.

# 5 Results

Results are given in Figure 3. The data is presented as a force-displacement plot, with target stiffness values also indicated.

Results show that the measured stiffness of the key is approximately 0.37N/mm, $r^2 = 0.98$. The testing covered a force range from 0gf to 170gf (approximately 1.67N), sufficient to characterise the key's operating range. Throughout this range, the response remained largely linear, with deviations assumed to be primarily a function of the lack of locating features for the key within the test rig. The key was free to move in the horizontal plane, which may have given rise to error.

Given that predicted/target stiffness was 0.39N/mm, the results indicate an error of 5.1%. Given the rudimentary nature of the test rig and the known limitations of the prediction methods, this was considered an acceptable result, and one that largely validates the approach used in the design phase.

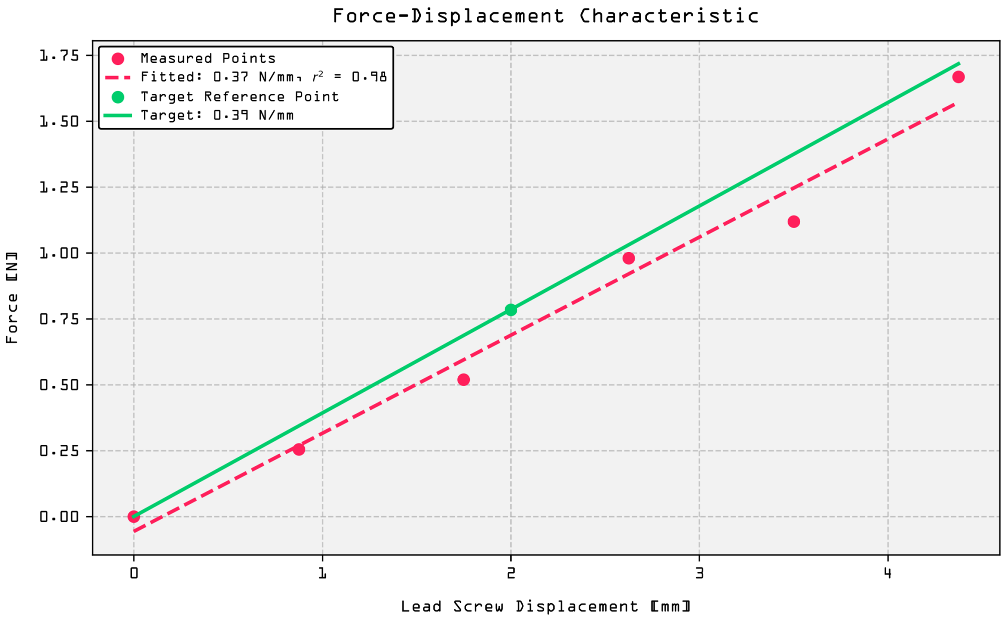


Figure 3: Test Results