# Fatigue Behavior and Monotonic Properties

# For

# AISI 8615 CA Steel
# Four Point Bending

## Iteration 156

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## Summary

The required strain-life fatigue data for AISI Iteration 156 has been obtained using bending tests. The material was provided by the American Iron and Steel Institute (AISI) in the form of metal bars. These bars were machined into bending fatigue specimens. The Rockwell C hardness (RC) was determined as the average of nine measurements. Constant-amplitude tests under bending were conducted in the laboratory at room temperature to establish the strain-life curve.

## Introduction

This report presents the results of fatigue tests performed on a group of 8615 CA Steel specimens (Iteration 156). The material was provided by the American Iron and Steel Institute. The objective of this investigation is to obtain the strain-life curve of the material under a four point bending cyclic test.

## Experimental Procedure

### Specimen Preparation

The material for this study was received in the form of bars. Bending fatigue specimens, shown in Figure 1, were machined from the metal bars. Before testing, the specimens had a final polish in the loading direction in the gauge sections using 240, 400, 500, and 600 emery paper and a thin band of M-coat D acrylic coating was applied along the central gauge section. The purpose of the M-coat D application was to prevent scratching of the smooth surface by the knife-edges of the strain extensometer, thus reducing the incidence of knife-edge failures.

### Test Equipment and Procedure

Hardness tests were performed on the surface of three fatigue specimens using a “Rockwell C” scale. The hardness measurements were repeated three times for each specimen and the average value was recorded. All fatigue tests were carried out in a laboratory environment at approximately $25^{o}$C using an MTS servo-controlled closed loop electro hydraulic testing machine. A bending rig was installed in the hydraulic testing machine as shown in Figure 2. An Extensometer was installed on the bending specimen to measure the strain as shown in Figure 3.

A process control computer, controlled by FLEX software [1] was used to output constant stroke amplitudes.

Axial, constant strain amplitude, fully reversed (R=-1) stroke-controlled fatigue tests were performed on bending specimens. The tests were run under stroke control and the corresponding strain measurements were recorded. The load-strain limits for each specimen were recorded at logarithmic intervals throughout the test via a peak reading voltmeter. Failure of a specimen was defined as a 50 percent drop in the tensile peak load from the peak load observed at one half the expected specimen life. The loading frequency varied from 0.5 Hz to 25 Hz.

## Results

### Constant Amplitude Fatigue Data

Constant amplitude fatigue test data obtained in this investigation are given in Table 1. A constant strain-amplitude fatigue life curve for the steel is given in Figure 4.

### Microstructure

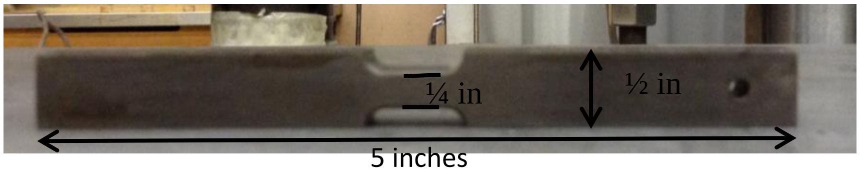
The microstructure was supplied by Chrysler lab as shown in Figures 5 and 6.

## References

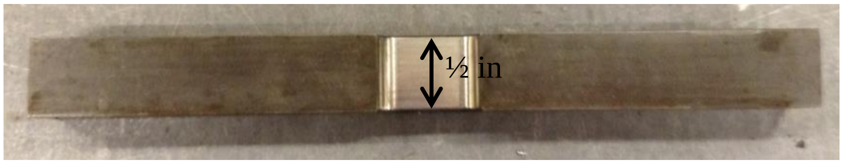
[1] M. Pompetzki, R. Saper, T. Topper, Software for rig frequency control of variable amplitude fatigue tests, Canadian Metallurgical Quarterly 25 (2) (1987) 181-194

## Note:

Some specimen IDs, a digital number with a letter “B”, such as 9B, it means this specimen (9) was tested at low strain amplitude without failure, then it was tested at high strain amplitude (9B).



Side view of bending specimen



Top view of bending specimen

Figure 1: Bending Fatigue Specimen

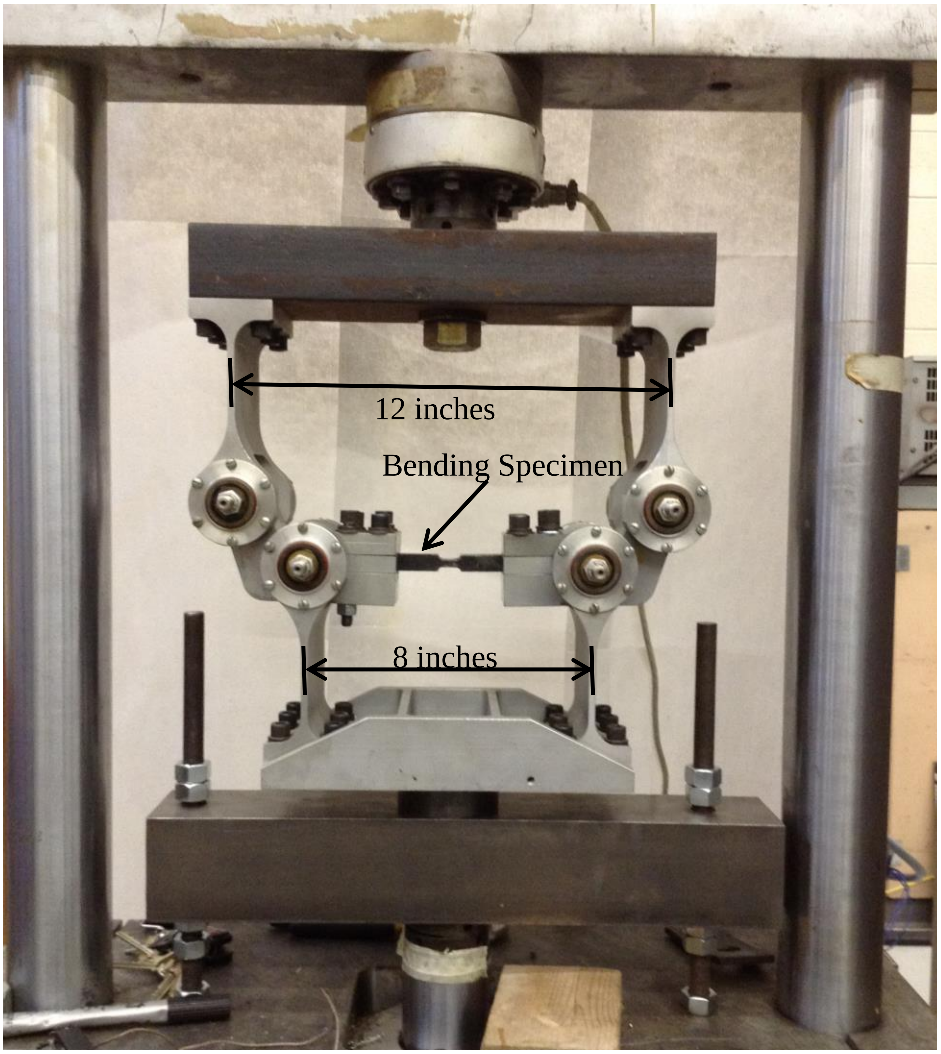


Figure 2: Bending Rig in the testing frame

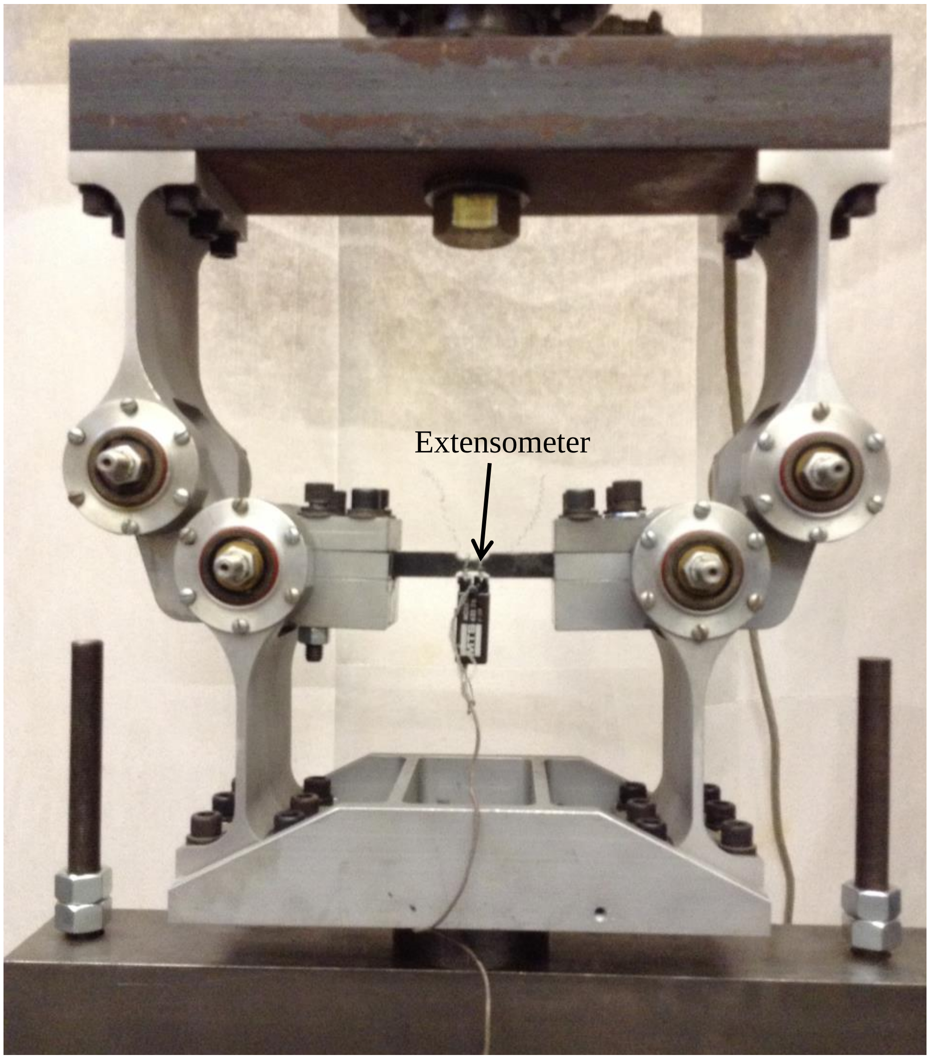


Figure 3:  Extensometer installed on the bending specimen to measure the strain

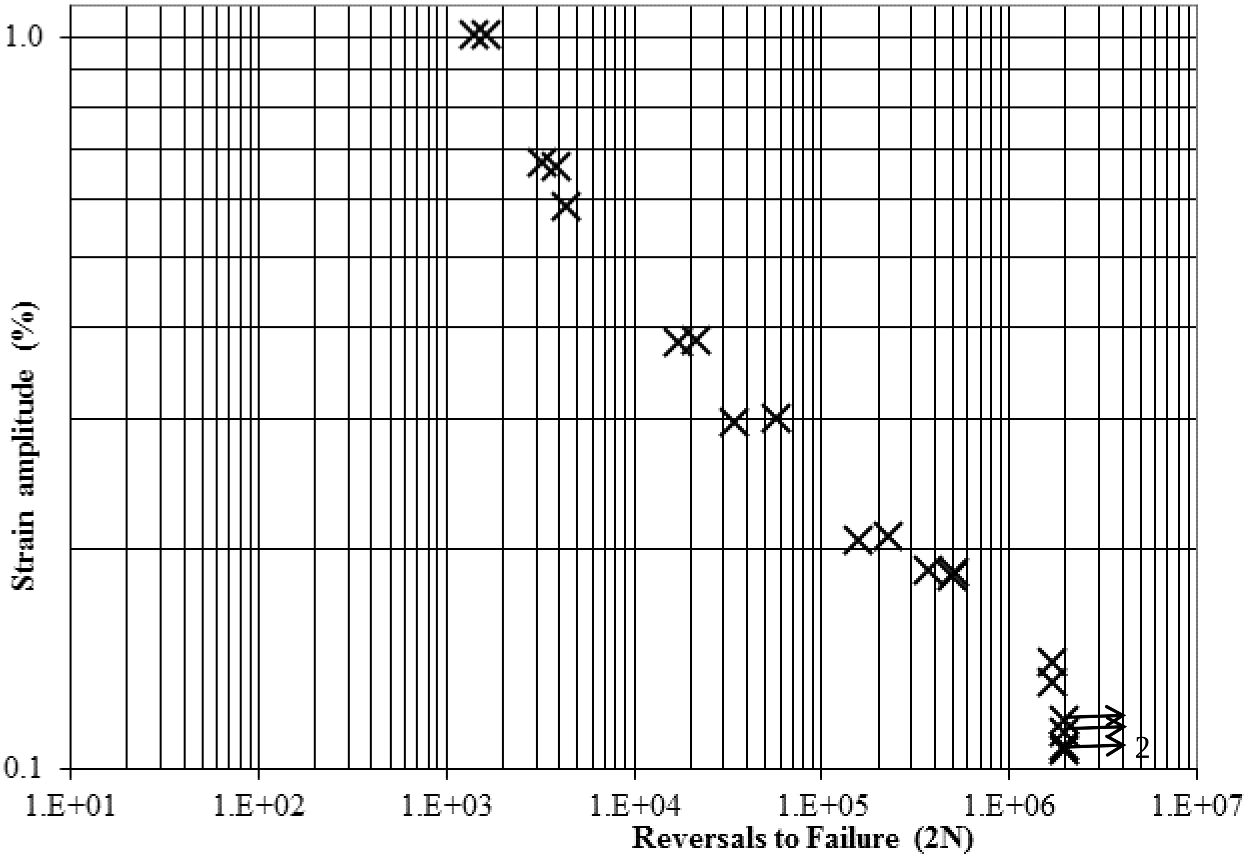


Figure 4: Strain-life fatigue curves for AISI 8615 CA (IT 156)

Figure 5: Microstructure of Iteration 156, high magnification

Figure 6: Microstructure of Iteration 156, low magnification

## Table 1: Constant Strain Amplitude Data for AISI 8615 CA Steel (IT 156)

| Sp. Id | Strain Amplitude (%) | Load (lb) | Reversals to Failure | Hardness |
|---|---|---|---|---|
| 1 | 0.585 | 639 | 4,364 | |
| 2 | 0.381 | 507 | 17,396 | |
| 3 | 0.664 | 628 | 3,880 | |
| 4 | 0.673 | 619 | 3,260 | |
| 7 | 0.297 | 429 | 34,856 | |
| 5 | 0.205 | 314 | 158,000 | |
| 6 | 0.106 | 187 | 2,000,000 | Average |
| 12 | 0.183 | 321 | 498,250 | HRC 30 |
| 11 | 0.186 | 307 | 368,750 | |
| 16 | 0.185 | 314 | 519,000 | |
| 19 | 0.139 | 252 | 1,697,834 | |
| 10 | 0.112 | 224 | 2,000,000 | |
| 14 | 0.107 | 231 | 2,000,000 | |
| 14B | 0.131 | 246 | 1,693,724 | |
| 8 | 0.116 | 221 | 2,000,000 | |
| 9 | 1.005 | 765 | 1,640 | |
| 9B | 1.005 | 814 | 1,410 | |
| 13 | 0.383 | 512 | 21,406 | |
| 15 | 0.301 | 445 | 57,618 | |
| 17 | 0.208 | 341 | 229,000 | |
| 18 | 0.302 | 425 | 66,100 | |