Experiment Number 03

What effect does running a hard moving specimen on a soft surface have on the quality of the friction signal?

Background

The implicit assumption when measuring friction between two surfaces is that the contact is flat. However, many tribological experiments give rise to contact conditions that, as a result of wear or plastic deformation, are not flat, with the result that the nominal friction force signal is disorderly.

Test Conditions

Moving Specimen:	6 mm diameter x 12 mm wide line contact nitride steel pin
Fixed Specimen:	NSOH BO1 steel gauge plate
Fixed Specimen Hardness:	Annealed (soft)
Load:	150 N
Lubricant:	Metal working oil (at 50^{o}C)
Stroke:	2 mm
Frequency:	30 Hz

Method

In addition to recording the r.m.s. friction value, periodic recordings of high speed friction data were made through-out the test sequence. Selected sets of high speed data were post-processed as follows:

1. The instantaneous friction signal was squared and the square root taken for each data point to give rectified values of the signal.
2. The rectified values were averaged over a number of cycles to give a mean value of friction.
3. The mean value was subtracted from the rectified values to give the “friction noise” level: the instantaneous variations in friction above or below the mean value.
4. The “friction noise” values were squared and the square root taken to give a rectified value of the “friction noise”.
5. The rectified value of the “friction noise” was averaged to give a mean value of “friction noise”.
6. The mean value of “friction noise” was divided by the mean value of friction to give a percentage noise level as a measure of the quality of the friction signal.

Results

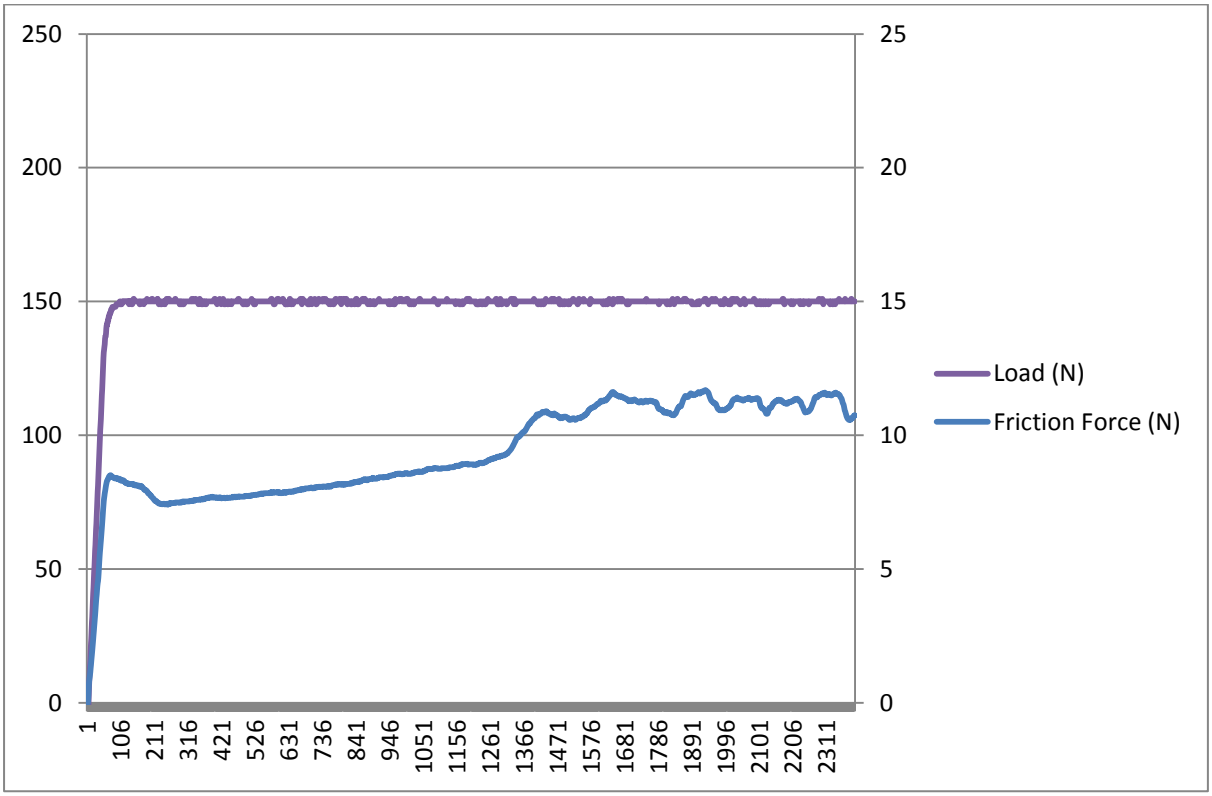

Figure 1: Load and Friction – 2 mm Stroke – 30 Hz – Soft Plate

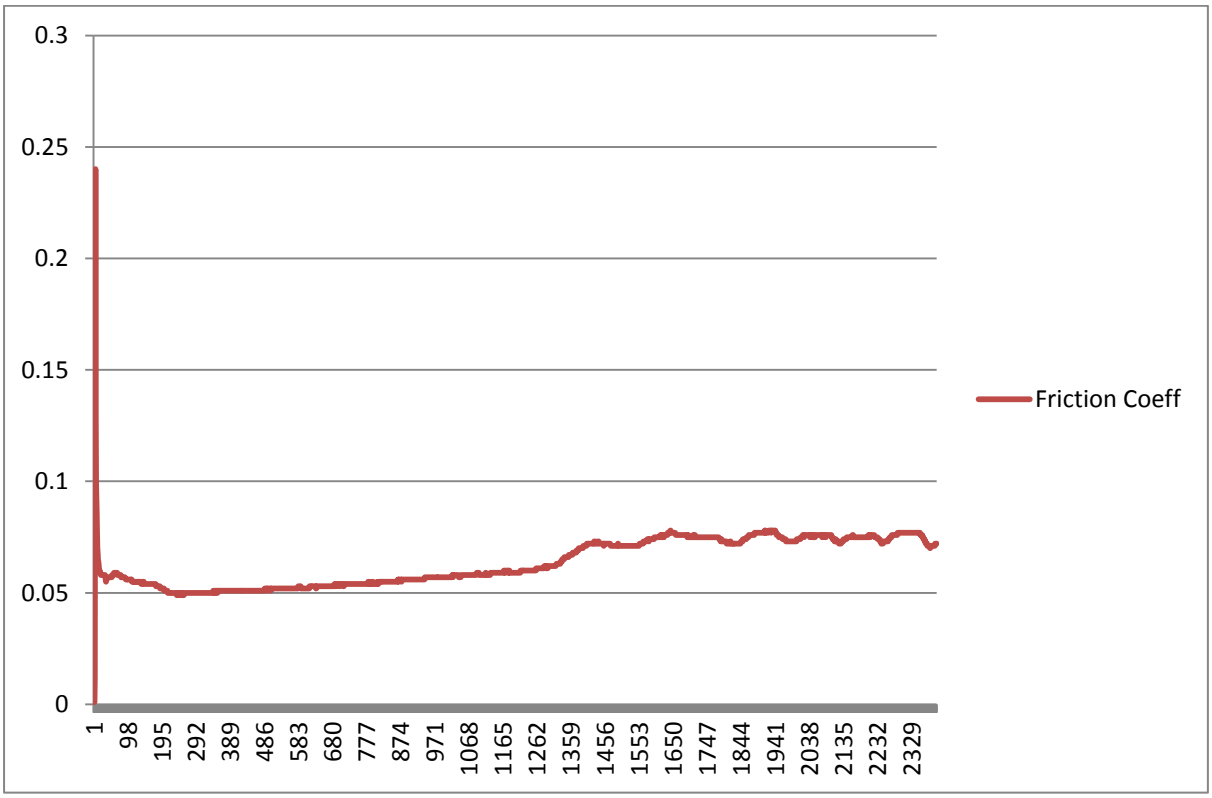

Figure 2: Friction Coefficient – 2 mm Stroke – 30 Hz – Soft Plate

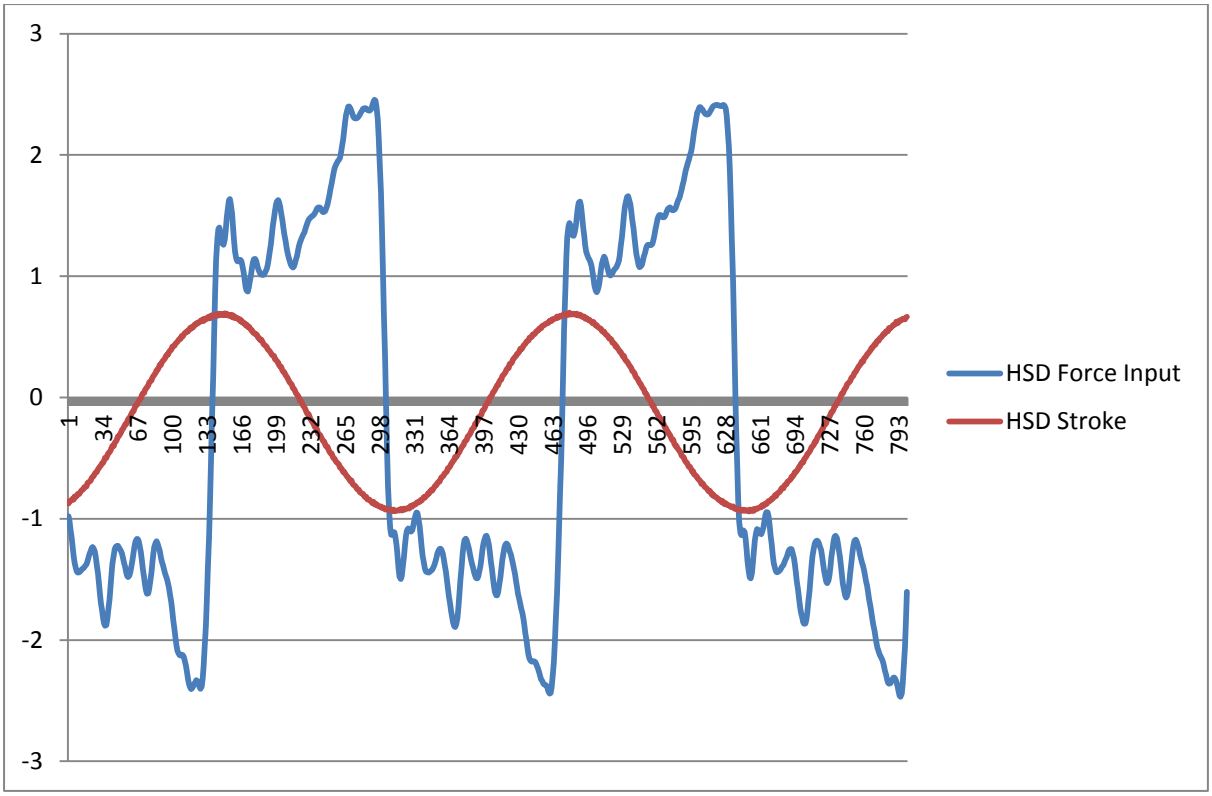

Figure 3: Instantaneous Friction – 2 mm Stroke – 30 Hz – Soft Plate - Test Start

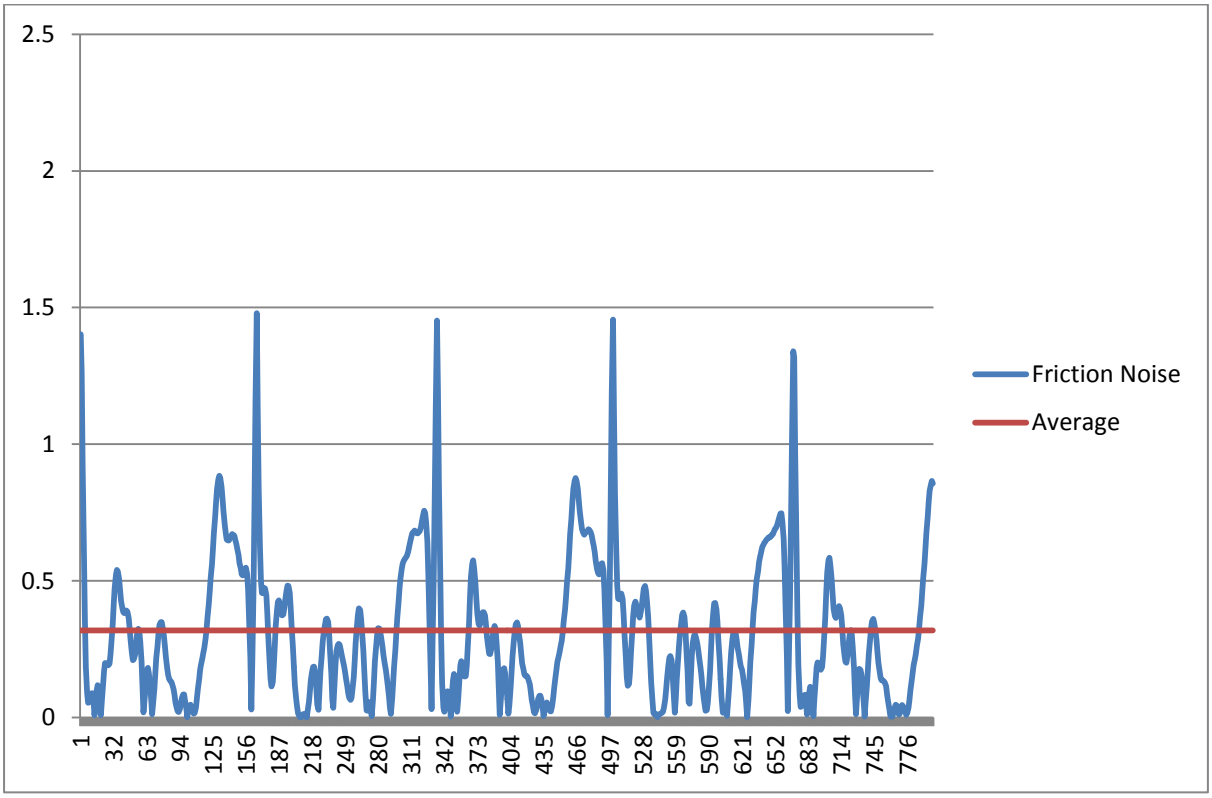

Figure 4: Friction Noise – Test Start

Mean Friction: 1.503 – Mean Friction Noise: 0.319 - Ratio: 21.20%

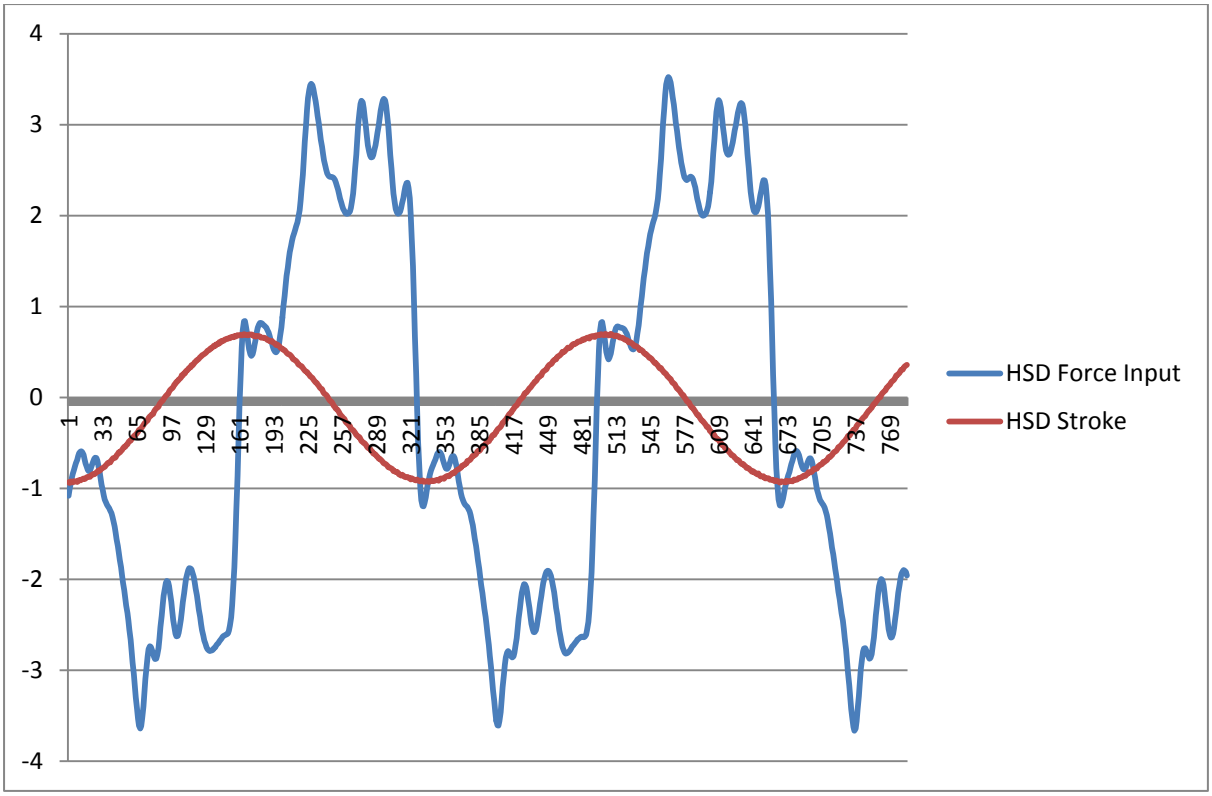

Figure 5: Instantaneous Friction – 2 mm Stroke – 30 Hz – Soft Plate - Test End

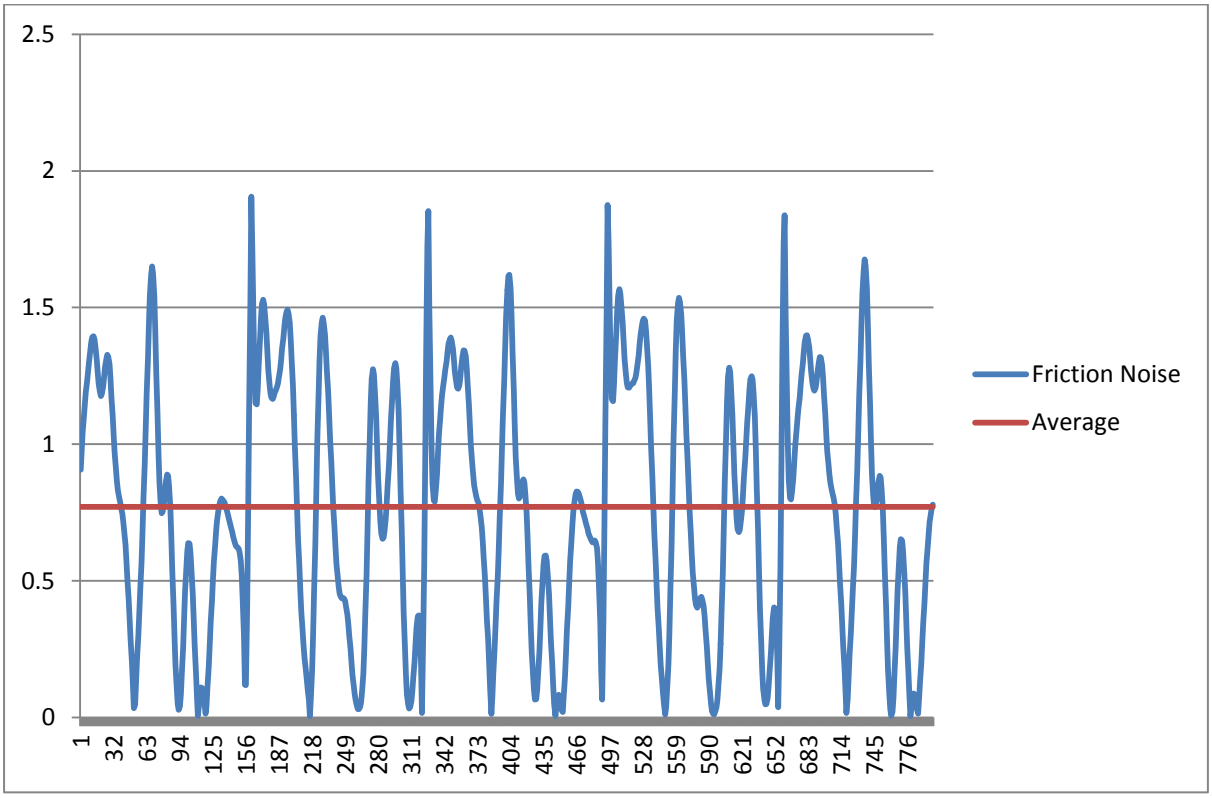

Figure 6: Friction Noise – Test End

Mean Friction: 1.987 – Mean Friction Noise: 0.771 - Ratio: 38.80%

Figure 7: Test Sample – Wear Scar Depth ~ 90 microns

Comments

1. The test starts with a high level of friction coefficient (of the order of 0.3) indicating severe adhesive wear at the outset.
2. The low speed friction signal indicates the on-set of scuffing or some other form of distress about half way through the test. This could of course simply be an indication that the surface has become so worn and damaged that the moving specimen no longer slides smoothly over the fixed specimen.
3. The wear scar depth is greatest at the mid-stroke position and least at the stroke ends. It follows that the motion path of the moving specimen cannot be flat.

Conclusions

1. The test produces a deep pit in the (soft) flat sample. This results in a progressively deteriorating instantaneous friction signal.
2. It is not clear what effect the interaction between the ends of the moving cylinder sample and the ends of the wear scar will have on the nominal friction force measurement. Contact at this point will of course result in shorting the electrical contact potential signal to ground, which may account for the lack of any contact potential measurement.