| Title | The influence of ultrasonic vibration on the coefficient of friction by use of the semi-circular ring |
| --- | --- |
| Sub Title | |
| Author | 水野, 正夫(Mizuno, Masao) |
| Publisher | 慶応義塾大学工学部 |
| Publication year | 1972 |
| Jtitle | Keio engineering reports Vol.25, No.10 (1972. ) ,p.123- 127 |
| JaLC DOI | |
| Abstract | The author investigated the snapping action of the semi-circular ring clamped at both ends and compressed symmetrically by a plane, as shown in Fig. 1, and evaluated from the experimental results the coefficient of the friction between the ring and the plane and also evaluated the decrement of the coefficient by the ultrasonic vibration of the plane. |
| Notes | |
| Genre | Departmental Bulletin Paper |
| URL | https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO50001004-00250010-0123 |

KEIO ENGINEERING REPORTS
**VOL. 25 NO. 10**

# THE INFLUENCE OF ULTRASONIC VIBRATION ON THE COEFFICIENT OF FRICTION BY USE OF THE SEMI-CIRCULAR RING

**BY**

*MASAO MIZUNO*

**FACULTY OF ENGINEERING**
**KEIO UNIVERSITY**
YOKOHAMA 1972

KEIO ENGINEERING REPORTS
VOL. 25, NO. 10, pp. 123-127, 1972

# THE INFLUENCE OF ULTRASONIC VIBRATION ON THE COEFFICIENT OF FRICTION BY USE OF THE SEMI-CIRCULAR RING

MASAO MIZUNO

**Dept. of Mechanical Engineering, Keio University, Yokohama 223, Japan**

(*Received Nov. 22, 1972*)

**ABSTRACT**

The author investigated the snapping action of the semi-circular ring clamped at both ends and compressed symmetrically by a plane, as shown in Fig. 1, and evaluated from the experimental results the coefficient of the friction between the ring and the plane and also evaluated the decrement of the coefficient by the ultrasonic vibration of the plane.

## 1. Principle

For the non-dimensional load of $PR^2/EI \leqq 2.696$, where $P$, $2R$ and $EI$ stand respectively for the load along the axis of symmetry, the mean diameter of the ring, and the bending rigidity, the plane touches the ring tangentially as shown in

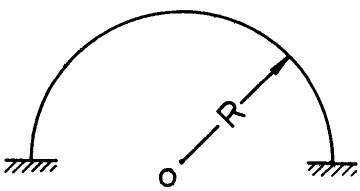



Fig. 1-a. Arrangement of the ring.

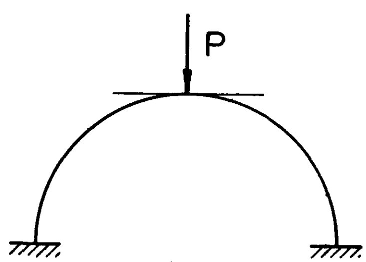



Fig. 1-b. Contact of the plane with the ring at the load $PR^2/EI < 2.696$

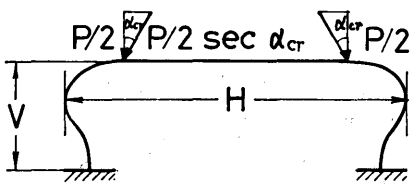



Fig. 1-c. Contact of the plane with the ring at the critical load.

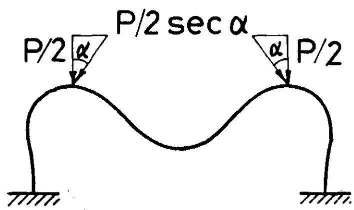



Fig. 1-d. Contact of the plane with the ring after snapping.

Fig. 1-b. If the load is $PR^2/EI>2.696$ but smaller than the critical load, the ring will touch the plane only in part and the rest will be curved. When the load exceeds the critical load, the straightened portion of the ring will sink down, will snap, as seen in Fig. 1-d. At the critical state as shown in Fig. 1-c, the straightened portion of the ring is just before the snapping and the ring will touch both ends of the straightened portion. The force acting at the ends is composed by the vertical loads (P/2) and the frictional forces $(P/2)\times\mu_s=(P/2)\times\tan\alpha_{cr}$, and the resultant forces are $(P/2)\times\sec\alpha_{cr}$ as shown in Fig. 1-c. The $\tan\alpha_{cr}$ is equal to the critical coefficient of the static friction $\mu_s$.

By taking $\alpha_{cr}$ as a parameter and applying the theory of " undulating elastica " to the curved parts of the ring, the relations between the vertical deflection $V$ and the horizontal deflection $H$ were caluculated and are given in Fig. 2, using the method developed by FRISH-FAY (1962).

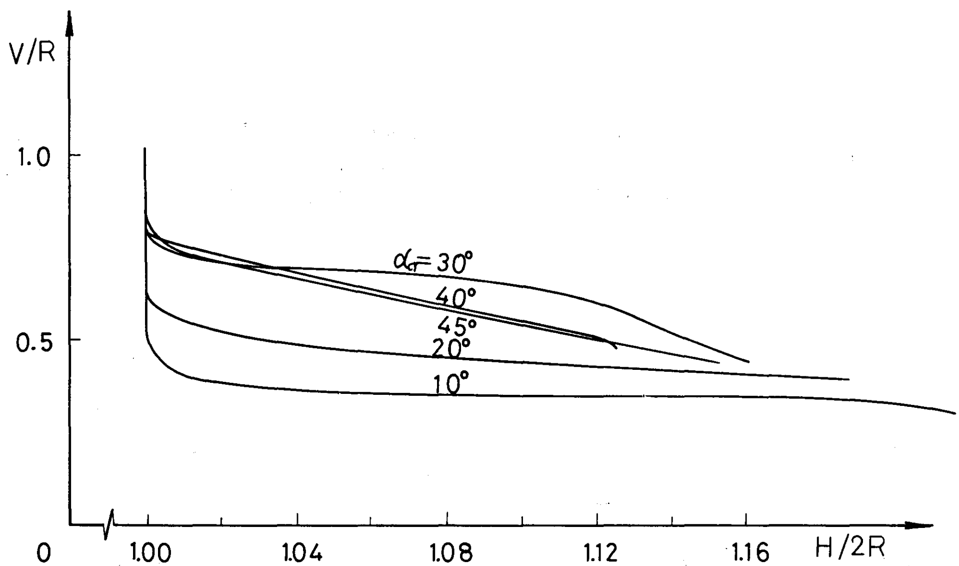



Fig. 2. Calculated relation between vertical deflection V and horizontal deflection H.

## 2. Experimental Method and Results

Fig. 3 shows the arrangement of the experimental apparatus, which consists of a universal testing machine, an ultrasonic transducer and a jig fixed at the

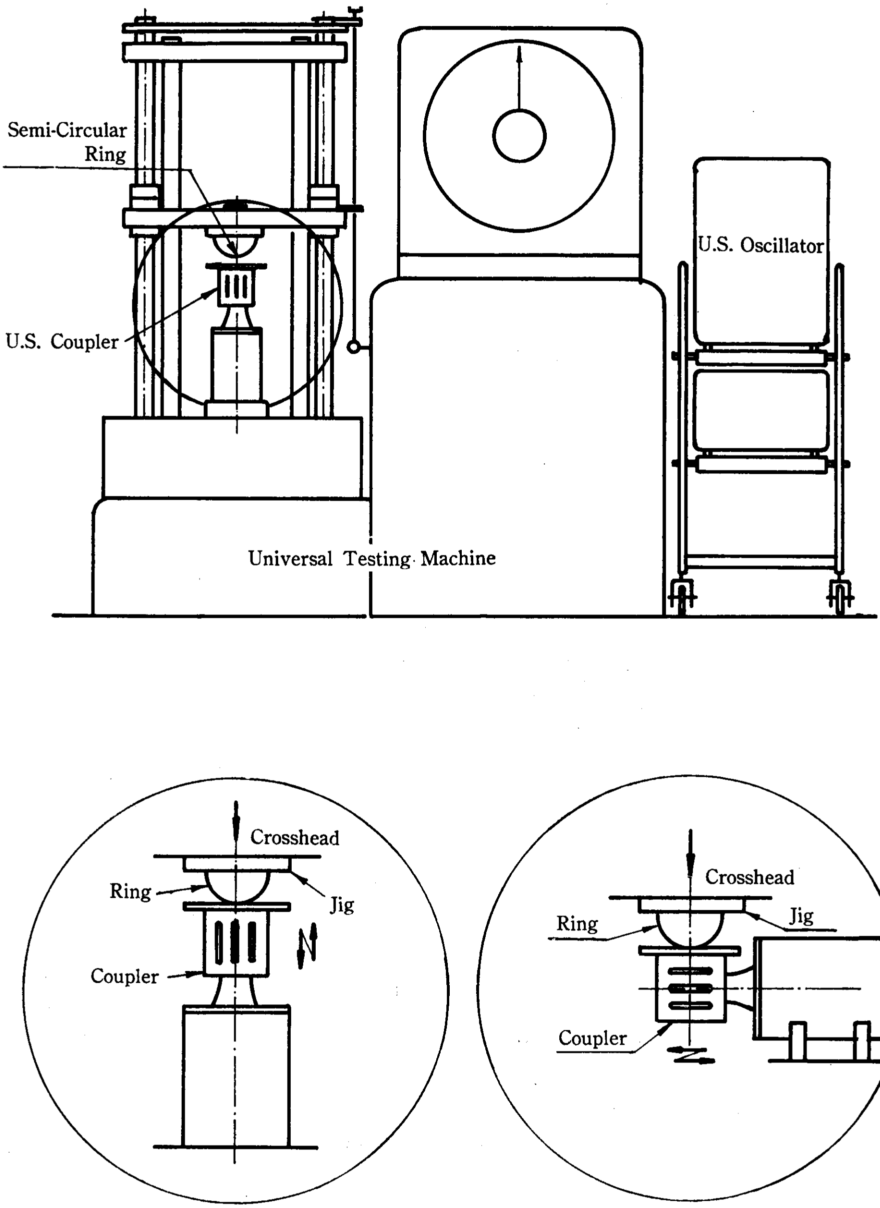



Fig. 3. Arrangement of the experimental apparatus.

cross head of the machine. Flat spring materials of hardened steel were used for the semi-circular rings, while the specimens for the plans were of 0.45% carbon steel and of aluminium.

Some of the results of the experiment are shown in Fig. 4.

The photographs of before and after critical state are shown as follows.

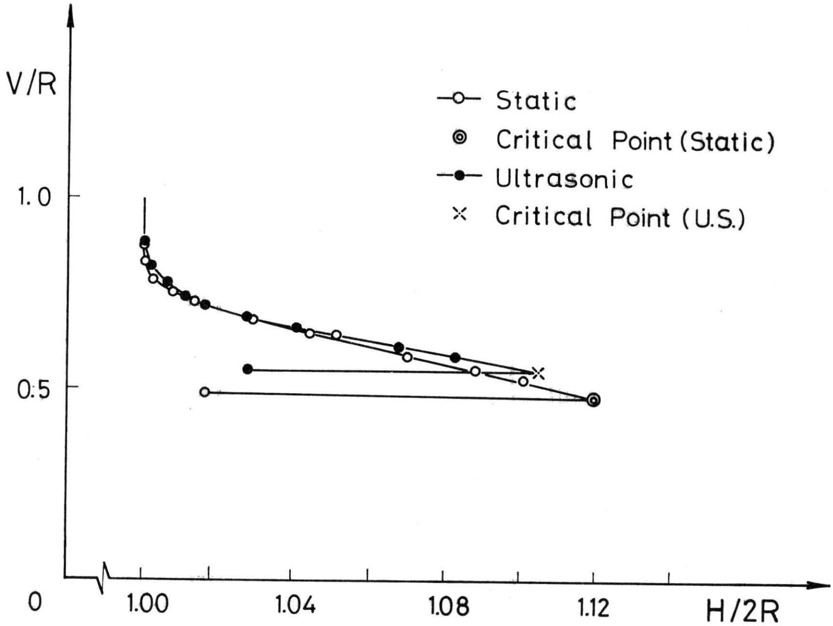
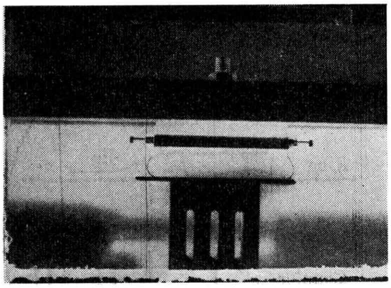
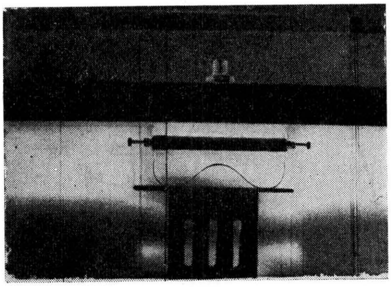



Fig. 4. V/R and H/2R of the aluminium plane.





It was confirmed that the coefficient of friction gradually decreased with the ultrasonic vibration of the plane. In the cases of steel and aluminium specimen, for example, an analysis of Fig. 2 and Fig. 4 shows the existence of the relations as follows.

Table of Experimental Results

| Conditions of Experiments | Materials of Plane | Values of $\mu_s$ |
|---|---|---|
| Static | Steel | 0.65 |
| | Aluminum | 0.78 |
| with Ultrasonic, ⊥ cal | Steel | 0.58 |
| | Aluminum | 0.45 |
| with Ultrasonic, // el | Steel | 0.40 |
| | Aluminum | 0.40 |

## 3. Discussion

Since the above values are extremely sensitive to the conditions of the experiment, further study on the subject is expected to increase the accuracy of evaluation. But the values of $\mu_s$ in the above Experimental Results Table are agreeable to the data given by RUIZ and KOENIGSBERGER (1970).

## REFERENCES

FRISH-FAY, R. (1962): *Flexible Bars*, Butterworths, London, 140.

RUIZ, C. and KOENIGSBERGER, F. (1970): *Design for Strength and Production*, Macmillan, London, 202.