6.1 INTRODUCTION

It has been reported in Section 2.8.2 that the rolling friction slideways exhibit a low level of damping under non-pre-loaded condition in spite of its having high stiffness and low friction. It is further said in Section 2.8.4 that comparing the technical and economic advantages, the best choice is the plain slideway with plastic inserts which is reported to exhibit a low friction combined with excellent damping. Hence this study is to investigate experimentally the damping behaviour of rolling-friction slideways and to compare it with that of a plain slideway with plastic insert by excitation test. The study includes the effects of roller sizes and their arrangement (pitch length) on the dynamic behaviour.

While the slides move in straight cutting mode (profile of work-piece parallel to the axes), only one slide is moving and the other slide is stationary. This study is undertaken to investigate the vibration response when the slideway pair is stationary.

6.2 EXPERIMENTAL SET UP

The design details of test rig for conducting vibration test on slides faced with plastic material have been discussed in Chapter 5. An identical set up was designed and fabricated introducing steel rollers between the slide and cast iron bed simulating an actual rolling friction slideway in a machine tool.
6.2.1 Basis for the Selection of Roller Sizes

With increasing roller length, the pressure on the contact area decreases and rigidity increases. The increase in stiffness, however, is proportionally less than the increase in length of rollers. In practice, when the roller length is increased, the cumulative error due to lack of parallelism of slideway in transverse direction and taper of the rollers also increases with corresponding increase in the unequal distribution of the load over the length. In view of this, the maximum length of the rollers recommended is 25 mm with length to diameter ratio not exceeding 1.5 - 2 [44].

From the rigidity point of view, for roller slideways, large diameter rolling element is preferable, because with increase in diameter, friction forces and pressure on the contact area are reduced, with corresponding increase in the wear resistance.

Based on the above recommendations a maximum length of 24 mm was selected and using the length to diameter ratio of 2, 12 mm diameter rollers are selected.

Similarly, for a 11 mm diameter roller with the length to diameter ratio as 2 the length of the roller will be 22 mm and that for a 10 mm diameter roller is 20 mm.

6.2.2 Basis for the Selection of Number of Rollers and Pitch Distances

The number of rolling elements is usually selected to ensure that the pressure in the contact area does not exceed the permissible value. The number of these rolling elements on each slideway should
not be less than 12 - 15 [44]. On the other hand, it is necessary that the load on each element due to the weight is not too low. For roller slide ways it is desirable to maintain the condition that

\[ P_{\text{in}} > 30 \text{ N/cm } [44] \]  \hspace{1cm} \text{...(6.1)}

Based on the above, the optimum number of rolling elements on each slide way surface is given by the formula,

\[ Z = \frac{G}{3b} [44] \]  \hspace{1cm} \text{....(6.2)}

Where \( Z \) = number of rolling elements
\( b \) = length of roller in cm
\( G \) = weight of slide acting on the given slideway surface in Newtons

Satisfying the requirements discussed above, the number of rolling elements selected for each slideway is 12. Over and above the weight of the slide and exciter, suitable dead weights were added to maintain the condition given in equation (6.1).

In the slideways, rolling elements should be distributed uniformly over the whole length, because the loads are applied within the length of the slideways and are shared equally among the rollers. The maximum pitch distance obtained in such distribution is 45 mm.

A reduction of pitch length means the arrangement of rollers at closed intervals and the resulting uncovered portion of the slide way is either in the middle or at both ends equally divided. In such
cases, the rollers should be placed towards the ends leaving the middle portion free for better resistance to tilting moments.

The arrangements of rollers with different pitch lengths are shown in Fig. 6.1. A sectional view of the experimental set up for rolling friction guideway is presented in Fig. 6.2.

6.3 EXPERIMENTAL PROCEDURE

The rolling friction slideway with 12 rollers on each side with a pitch length of 45 mm, 40 mm, 35 mm and 30 mm was subjected to forced vibration using an electro-dynamic exciter. The exciting force applied in a direction normal to the sliding surface was 50 N.

An acceleration pick up, placed close to the excitation point was used to measure the vibration velocity which is proportional to the direct response of the system. The response was measured in the frequency range of 1 Hz to 200 Hz. The experiment was performed for rolling elements of 12, 11 and 10 mm diameters.

The response curves, excitation frequency versus vibration velocity are presented in Figs. 6.3, 6.4 and 6.5. The measured data are given in Tables A4.1, A4.2 and A4.3 in Appendix 4.

A similar experiment on the test rig for plain slideway with plastic insert as per the procedure outlined in Chapter 5 was performed with Turcite-B thermoplastic insert under identical conditions. The response curve drawn for the plastic inserted slideway is shown in Fig. 6.6.
FIG. 6.1. ARRANGEMENT OF ROLLERS WITH DIFFERENT PITCH LENGTHS
FIG. 6.2. SECTIONAL VIEW OF THE TEST RIG OF ROLLING FRICTION SLIDEWAY

B - TEST BED
S - SLIDE
R - ROLLERS (12 mm dia & 24 mm length)
FIG. 6.3. VIBRATION RESPONSE OF ROLLING ELEMENT GUIDEWAY AT DIFFERENT PITCH LENGTHS. DIAMETER OF STEEL ROLLER = 12 mm. [WHEN THE TABLE IS NOT SLIDING]
FIG. 6.4. VIBRATION RESPONSE OF ROLLING ELEMENT GUIDEWAY AT DIFFERENT PITCH LENGTHS. DIAMETER OF STEEL ROLLER = 11 mm. (WHEN THE TABLE IS NOT SLIDING)
FIG. 6.5. VIBRATION RESPONSE OF ROLLING ELEMENT GUIDEWAY AT DIFFERENT PITCH LENGTHS. DIAMETER OF STEEL ROLLER = 10 mm. [WHEN THE TABLE IS NOT SLIDING]
FIG-6.6. VIBRATION RESPONSE OF TURCITE-B SLIDE WAY UNDER NON-SLIDING CONDITION