

The RoGlider – a Sliding Bearing with an Elastic Restoring Force

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ABSTRACT

The research on a number of new approaches to seismic isolation continues with the development of a RoGlider capable of supporting both light and high vertical loads with an effective co-efficient of friction of ~11% together with an appropriate elastic restoring force. Preliminary tests on prototype RoGliders have been promising.

INTRODUCTION

Internationally, 'Seismic Isolation' is now an accepted method for reducing the forces transmitted to a structure during an earthquake as illustrated by ASSISI conferences held every two years¹ and is applicable to both old² and new structures³. 'Seismic Isolation' reduces the forces transmitted to the structure by first increasing the flexibility of the support thereby increasing the structures natural period beyond the peak of the earthquake and secondly by adding damping thus reducing the energy transmitted to the structure^{4,5}.

Ideally, each seismic isolator should consist of two components, an elastic restoring force component plus a damping term. A good example is the lead rubber bearing (LRB) where the rubber/steel layers provide the elastic restoring force and support the structure while the lead plug produces the required damping. In addition the LRB has an estimated lifetime of more than 100 years and excellent fire resistance⁶. Our aim is to develop the RoGlider™ so that it can be considered as an alternative to the LRB and also be used for light loads and large displacements where it often becomes very difficult to use the LRB. We are continuing to develop other isolators such as the RoBall™ which is suitable for light loads⁷.

DESCRIPTION AND PRELIMINARY TESTS OF THE ROGLIDER

The RoGlider™ is a sliding bearing which includes an elastic restoring force. The actual configuration is dependant on the details of the structure being isolated and the expected earthquake. The RoGlider we present is a double acting unit with the restoring force provided by two rubber membranes (Fig. 1).

This double acting RoGlider™ consists of two stainless steel plates with a PTFE ended puck sitting between the plates. Two rubber membranes are attached to the puck with each being joined to the top or bottom plates. When the top and bottom plates slide sideways with respect to each other, diagonally opposite parts of the membrane undergo tension or compression.

The tension components provide the restoring force between the plates while the compression parts buckle (Figs. 2 - 4) and provide little or no restoring force.

The particular double acting RoGlider we have tested has a maximum displacement of $\pm 600\text{mm}$, a maximum vertical load of 1MN , with an outside diameter of $\sim 900\text{mm}$ and a coefficient of friction at $\sim 0.5\text{m/s}$ of $\sim 11\%$. Following this particular membrane approach we expect to be able to increase the elastic stiffness by a factor four or more times using our latest designs.

The RoGlider was tested in our test rig capable of providing a vertical force of up to 6MN , horizontal force of up to 700kN and maximum displacement of 600mm .

The effect of vertical force on the force displacement curves is illustrated in figure 5, at 850kN , and figure 6, where the vertical load is 110kN . For both of these vertical forces the horizontal stiffness is $\sim 100\text{kN/m}$.

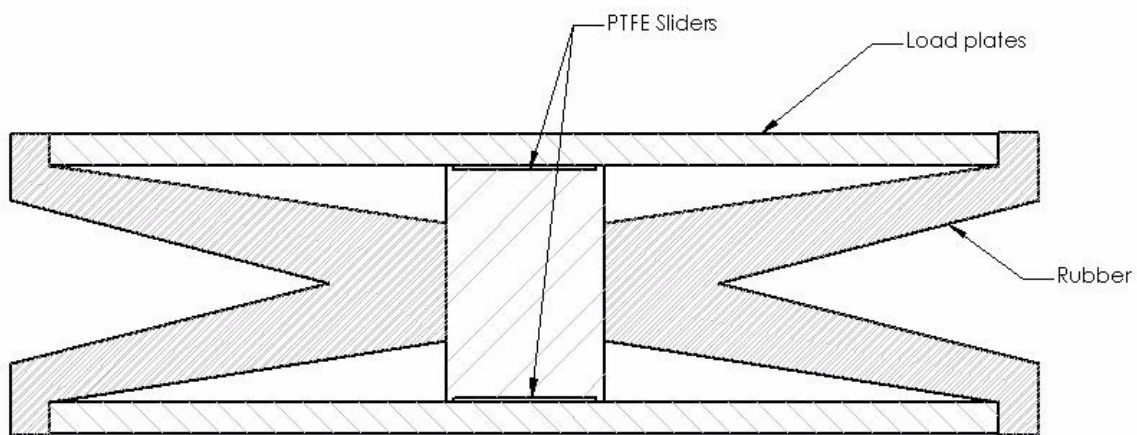


Figure 1: RoGlider Section



Figure 2: RoGlider ready for testing
Displacement 0mm , vertical force of 850kN



Figure 3: RoGlider during Test
Displacement -150mm , vertical force of 850kN



Figure 4: RoGlider during Test
Displacement +575mm, vertical force of 110kN

ROGLIDER

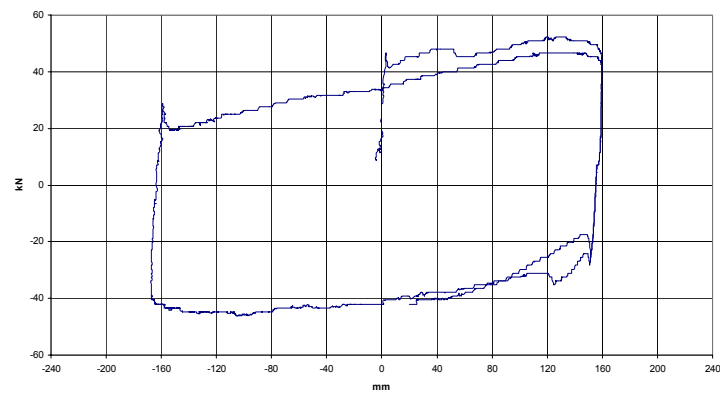


Figure 5: RoGlider Force Displacement Curve – Vertical force of 850kN

ROGLIDER

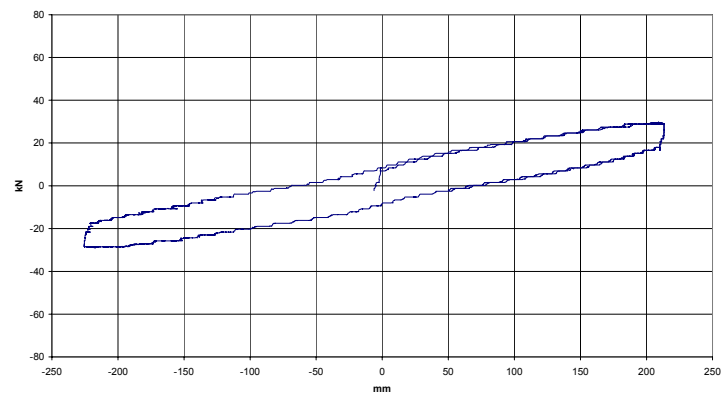


Figure 6: RoGlider Force Displacement Curve – Vertical force of 110kN
Note that the stepped nature of the loops is due to the resolution of the load-cell and is not a characteristic of the RoGlider.

CONCLUSIONS

The RoGlider which we have presented represents one of many possible configurations we are developing. At this stage this version of the double acting RoGlider is a promising candidate for a commercially viable seismic isolator for both high and low vertical loads.

The model of the RoGlider tested has an effective coefficient of friction at $\sim 0.5\text{m/s}$ of $\sim 11\%$ together with an elastic restoring force of $\sim 100\text{kN/m}$.

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