A ROBALL WITH AN ELASTIC RESTORING FORCE

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ABSTRACT

We present recent research on the development of the seismic isolator, the RoBall, a rubber container holding a number of metal balls. This version of the RoBall, which in addition to friction includes an elastic restoring force and contains 7 metal balls, took a maximum vertical load of ~0.5 MPa and had a force-displacement wavelength of ~ 450 mm.

INTRODUCTION

As illustrated by the ASSISI conferences held every two years [1] there is a great deal of interest in the economic application of 'Seismic Isolation' to significant structures throughout the world [2, 3].

In this paper, we present progress made in both research and development of the RoBall™ a device suitable for use as a seismic isolator for light loads. Our research on the RoBall™ has continued with the development of an improved version, which in addition to a friction force includes a restoring force. The research on the RoBall and the RoGlider [4] are parts of our efforts to provide economic solutions to the problems of seismic isolation.

Brief summaries of the latest developments of the RoBall follow.

Experimental Behaviour of the Improved RoBall™

We present the preliminary experimental results of an improved isolation device, the 'RoBall™'[5]. In our latest version of the RoBall the top and bottom surfaces of the rubber container are flat and the sides are curved as illustrated in Figure 1. It contains seven solid balls.

The RoBall was tested by placing the device between a flat plate and the laboratory concrete floor with a weight on the plate representing the vertical load (Figures 2 & 3). The weight and plate were then driven back and forth using our 700 kN by 500 mm hydraulic actuator via a load cell. Displacements were measured using a 700 mm displacement transducer with the results being logged on a computer.

Other designs of the RoBall suitable for larger displacements could include 13, 19, 25 or more solid balls in close packed arrays.

The sides of the RoBall may be made thicker than the top and bottom surfaces thereby contributing to a restoring force for small displacements (Fig. 4) while for large displacements there is cyclic restoring with a force-displacement wavelength approximately twice the diameter of the RoBall (Fig. 5). The oscillating force, elastic and/or friction, is probably due to the increase in thickness of the rubber at the RoBall's perimeter and the effect of the flat top and bottom surfaces. Another effect which may be of importance is the contribution to the friction and possibly causing an elastic restoring force via the elastic deformation produced because the distance travelled in one revolution of the RoBall ranging from a maximum of approximately twice the diameter of the

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RoBall at its centre 'A-A', figure 1, to a lesser value towards its outer edge 'B-B' and zero at the outer edge, 'C'.

The rolling action of the RoBall means that the device itself has no design displacement limit and so the maximum displacement is limited only by installation requirements. The dynamic behaviour of the device is independent of both frequency and ambient temperature within ranges that are applicable to most practical installations. The effective friction coefficient, i.e., the ratio of the nominal yield shear force to the compression force, of the prototypes, is ~0.1.

The applications for the model of the RoBall containing solid spheres are expected to be for protecting light equipment and light structures from mechanically generated or earthquake induced vibrations.

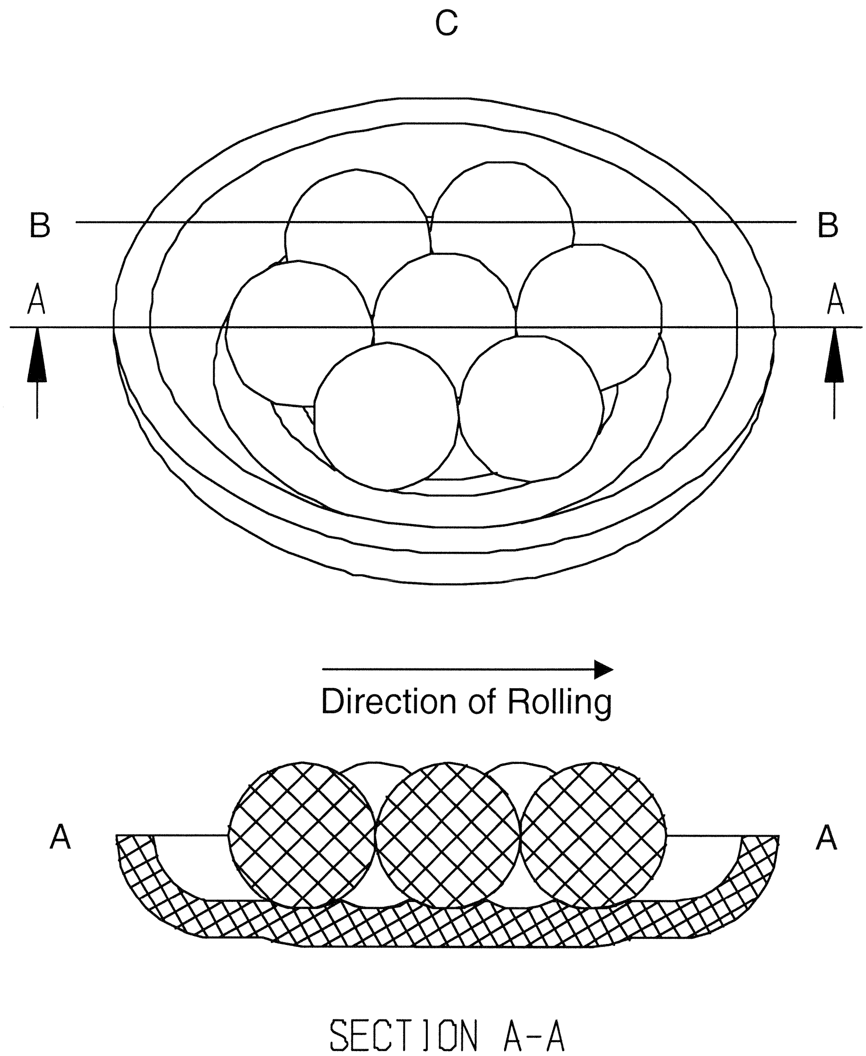

Figure 1. A Seven-Ball RoBall.

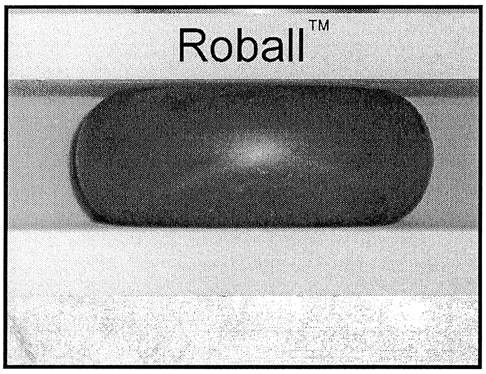

Figure 2. RoBall under Vertical Load

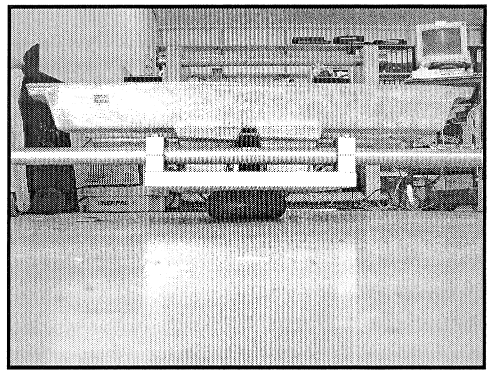

Figure 3. RoBall with 7 Internal Balls being Tested on Concrete Floor in RSL's Laboratory

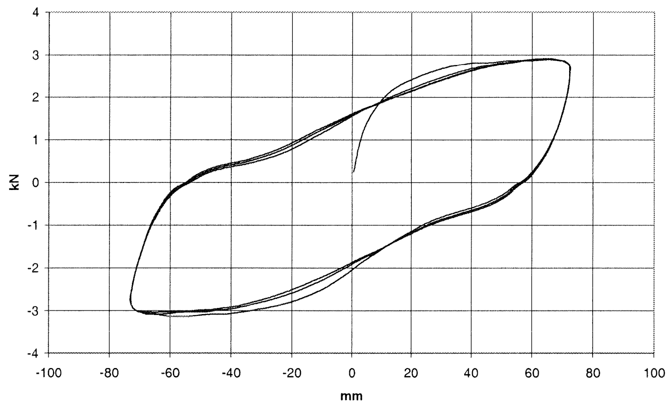

Figure 4. RoBall - Small Displacement Showing the Restoring Force Characteristic

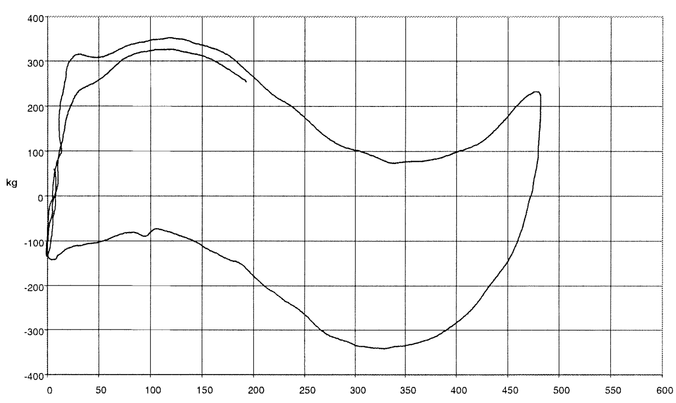

Figure 5. RoBall – Large Displacement with Cyclic Shear Forces

CONCLUSIONS

For light loads the RoBall [6] promises to be an economic alternative to existing seismic isolation devices providing both the elastic restoring force and the damping.

ACKNOWLEDGEMENT

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