Model to demonstrate how rockbolts work

In the 1960s I visited the laboratories of the Snowy Mountains Authority in Cooma, Australia and I was shown a model used by Mr Tom Lang to demonstrate how rockbolts work. He had used many innovative rock engineering concepts in the design of the caverns and tunnels of the Snowy Mountains Project and this model was one of his educational tools. I was so impressed by this model that I used a version of it in teaching a graduate course on rock engineering at the University of Toronto. As one of their projects the students would assemble this model from scratch and so discover for themselves how the rockbolts work. The series of photographs included in this document were taken during one such project. The model in these photographs was based on a version of Tom Lang's model constructed by the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi.

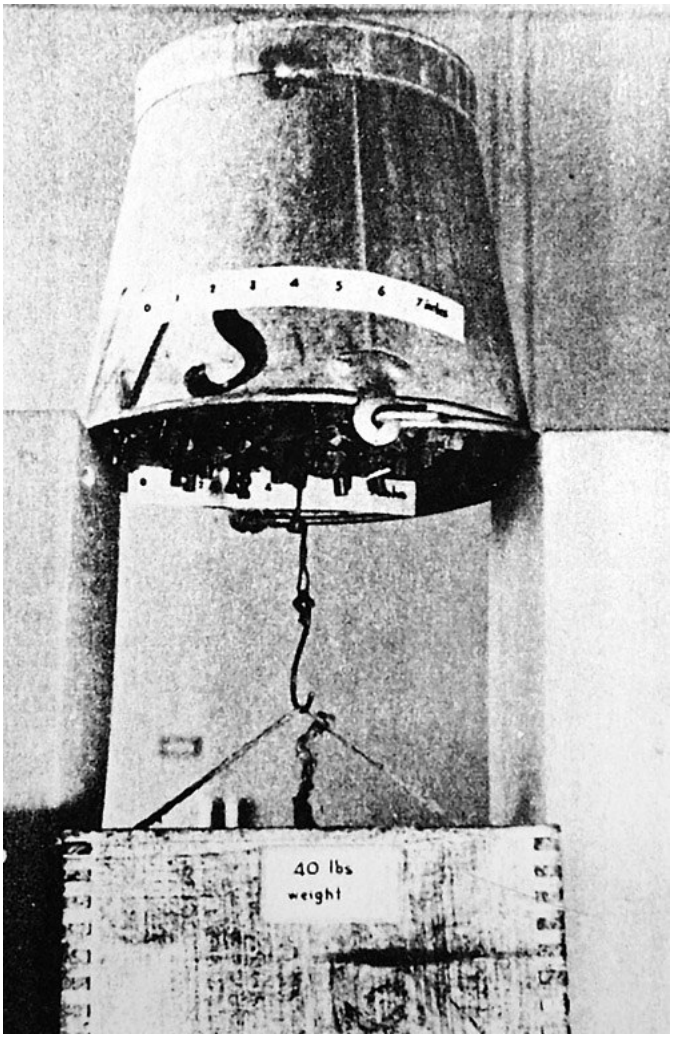

Figure 1: The rockbolt model in Tom Lang's office in Cooma, Australia. The inverted galvanised bucket contained gravel which was held together by means of a pattern of miniature rockbolts. In addition to binding the gravel together and creating sufficient friction to hold it in the bucket, a 40 lb (18 kg) weight was suspended from a small beam attached to the rockbolts.

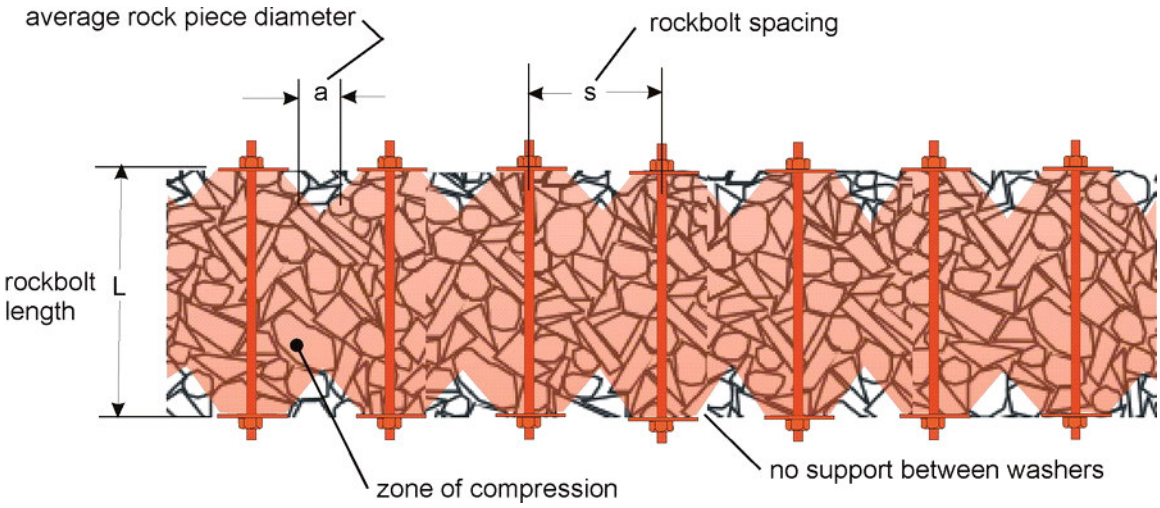

Figure 2: Tom Lang's explanation of how rockbolts work. A zone of compression is induced in the region shown in red and this will provide effective reinforcement to the rock mass when the rockbolt spacing s is less than 3 times the average rock piece diameter a. The rockbolt length L should be approximately 2s. Note there is no support between the washers (unless mesh or shotcrete is applied) and the rock pieces will fall out of these zones on the underside of the beam.

Figure 3: The empty frame of the rockbolt plate model.

Figure 4: Miniature rockbolts ready for installation.

Figure 5: Uniformly sized clean gravel for the plate.

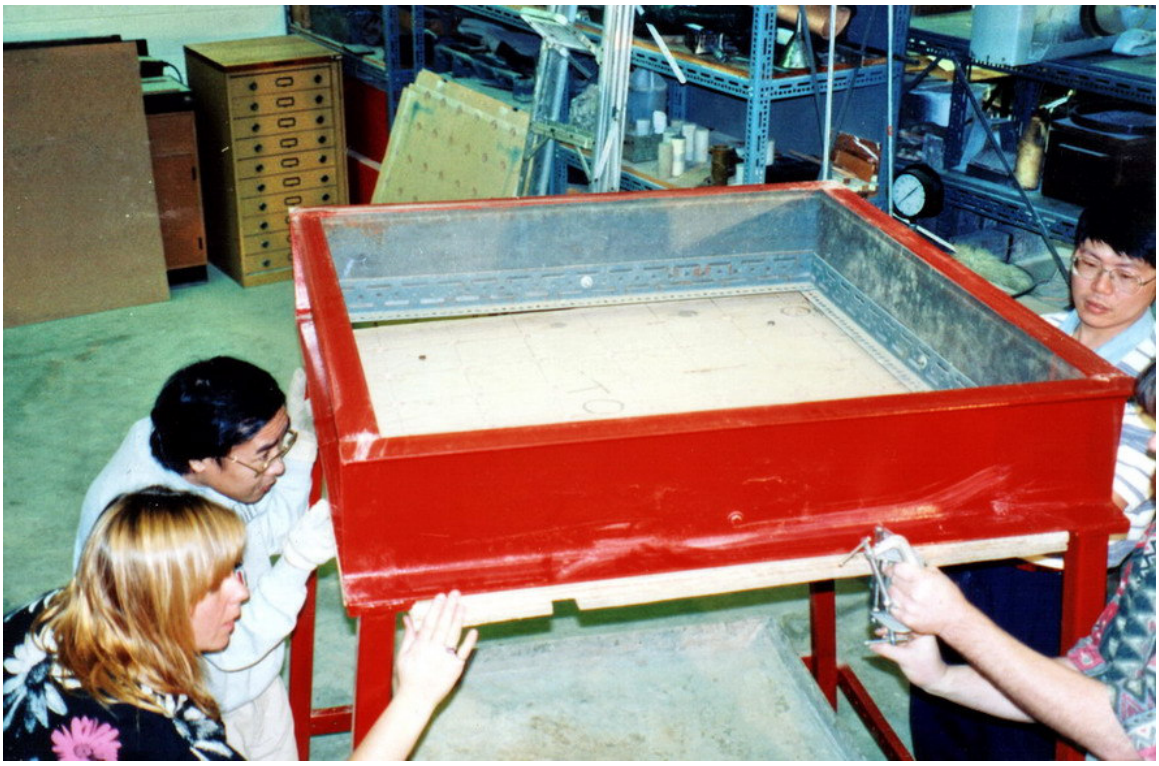

Figure 6: Attachment of the temporary base to the model frame.

Figure 7: Positioning the rockbolts in holes drilled into the temporary base.

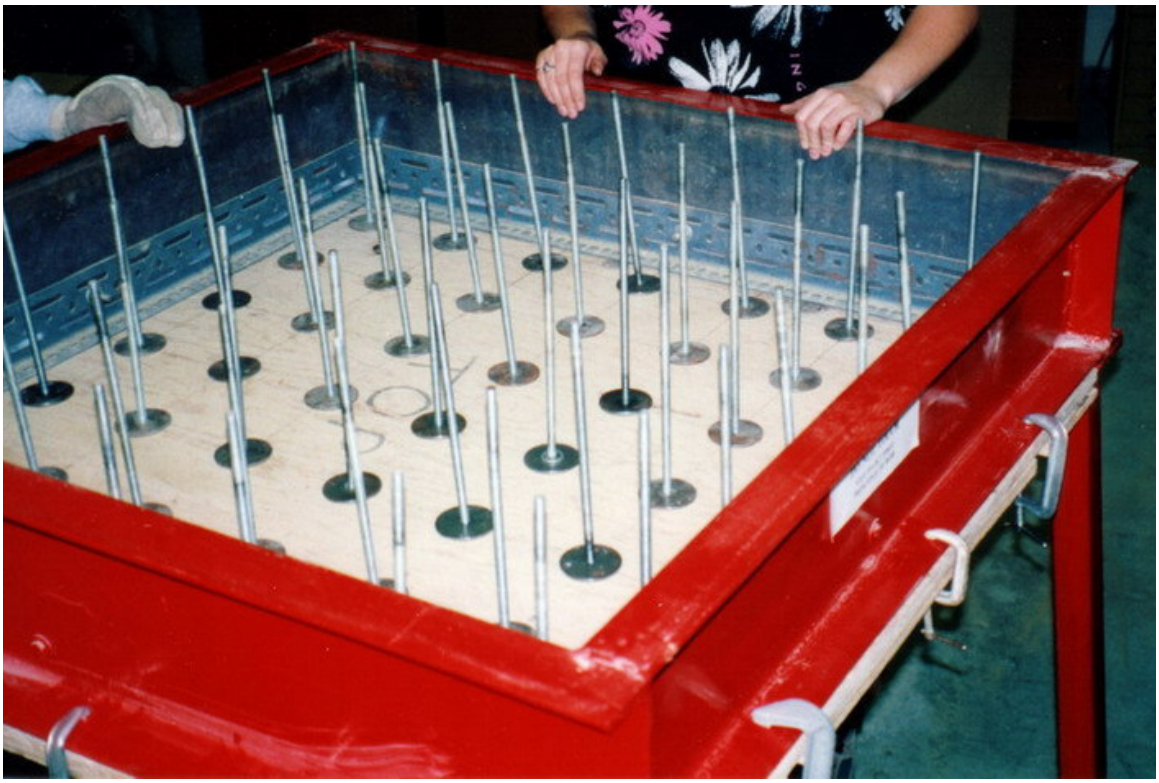

Figure 8: The rockbolts in position ready for the gravel to be placed.

Figure 9: Placing the gravel in the frame.

Figure 10: “Mechanical compacting” of the gravel.

Figure 11: Washers and nuts placed on the rockbolts and tightened.

Figure 12: Holding the bottom nut during bolt tightening.

Figure 13: The temporary base removed from the self-supporting rock plate.

Figure 14: The load-carrying capacity of the bolted gravel plate.