

Structural model studies for the Hendrik Verwoerd Dam

J. C. CHAPMAN, B. CREBER & P. J. D. GUILÉ

Mr D. W. Green, Binnie & Partners

The stress analysis of the dam obtained by finite element methods was confirmed by the model studies. This was to be expected as the validity of the method has been proved on a number of occasions when applied to similar structures. This being so the main interest of the studies centred on the original object of determining the stress distribution in the control blocks. Could the stress pattern at the interfaces between the dam and control blocks have been simulated as accurately as necessary by using many fewer points of application for gravity and hydrostatic loading on the arch?

64. Would the Authors give some figures for the dimensions of the culverts and comment on the reasons for the selection of a square section which would inevitably lead to higher stress concentrations than either an elliptical or a circular section?

65. In § 1 the Authors refer to a heel section on the upstream side which was modelled in timber and in § 5 it is stated that it was impossible to model the heel in concrete because of the overload it would be required to carry for the failure test. The introduction of the timber heel produces a discontinuity of approximately one third the height and base width of the dam at the centre section. I would have thought that such a large discontinuity would have had a significant bearing on the loading and possibly the mode of failure of the dam.

66. Although the state of the dam is described in detail at or near failure no details are given of the stress pattern around the culverts at this stage. Could the Authors expand on the text in this respect?

67. Would the Authors give some indication of the time and cost of constructing and testing the model and analysing the results?

Dr Chapman, Mr Creber and Mr Guile

The total capacities of the loading systems were dictated by the requirement to carry out a failure test. To be certain of achieving failure it was considered necessary to design the gravity loading system for a four times overload and the hydrostatic system for a six times overload. The total loading capacities were 1080 tons and 1548 tons respectively. The size of the discs used in the gravity system was limited by the actual thickness of the model dam. Also the load applied through each disc at full overload could not be allowed to overstress the concrete immediately under the disc. As will be seen from Fig. 6, an essential feature of the gravity loading system was that the discs were all equally loaded. These criteria fixed the maximum size of each disc, the load it could carry and hence the total number required. At the model scale being used it was considered that the hydrostatic loading would be adequately repre-

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sented if the area of each loading plate were restricted to be not greater than 100 sq. in. The number of plates and jacks followed from this criterion. The jack sizes used followed from structural and geometrical considerations of the loading linkages.

69. The culverts tapered from 28.0 ft wide by 33.6 ft high at the upstream end to 28.0 ft wide by 25.0 ft high at the downstream end. Their rectangular shape was dictated by the need to accommodate stop beams at the upstream end and the main radial control gates at the downstream end.

70. The heel structure built into the prototype is structurally independent of the main dam structure and transmits the hydrostatic loading to the dam at discrete points as did the timber heel structure on the model. The same discontinuities exist therefore in both the model and the prototype.

71. The state of strain in and around the spillway culverts was monitored right up to failure. The maximum compressive stress $E\epsilon$ recorded was of the order of 2000 lb/sq. in. and the rise in stress followed the expected pattern. Large apparent tensile stresses at the upstream ends of the walls between the culverts were recorded but were considered to be due to strain gauges recording the opening of cracks rather than recording a true state of strain. Otherwise there were no visible indications of distress in the areas around the culverts.

72. The cost of the model studies was £35 000 and the time that elapsed from inception to completion was 3½ years.