SYNOPSIS

Circular siphons have been used in some of the dams in India for passing surplus flows from reservoirs. The theory of these is not fully understood and some of these siphons have not been functioning satisfactorily. Hence experimental and theoretical investigations on this type of siphon have been conducted and the results studied. This forms the subject matter of the present thesis. The thesis is divided into seven chapters.

Chapter I deals with the introduction, historic development and previous work done on the study of prototypes, and on models (including both hydraulic and electrical analogy models). The defects in the earlier circular siphons and the aspects taken up for investigation in the thesis are stated.

Chapter II covers the phenomenon of priming and gives a precise definition of priming, priming depth, capacity of the siphon etc., and also covers preliminary studies on small model siphons in order to choose a suitable model for large scale detailed experiments.

Chapter III covers the studies on hydraulic model of the Hirebhasgar siphon and gives the experimental results. The causes for its unsatisfactory performance have been discussed.

Chapter IV deals with the model in which certain improvements have been incorporated and presents the experimental results and conclusions. The two models, i.e., the model of the existing prototype and the improved model, both have the same height and diameter, but different (i) shapes of funnel (ii) ratios of bend radius to shaft radius and (iii) proportions of domes. The improved design is the outcome of a large number of experiments on models of various proportions. The studies have helped to reveal the defects in the existing model and to offer suggestions for improvements. The main points brought out are :

(1) The existing prototype has been reported to flow partially and its behaviour is uncertain. The model also reflects these uncertain characteristics. The experimental data obtained in the thesis reveal the causes of uncertainty in the siphonic action and partial flow. The improved model, with the following new features (i) streamlined funnel (ii) easy bend and (iii) large dome, always flows fully and with guaranteed certainty of

behaviour and thus disproves the unfounded belief of earlier investigators that air pockets would be formed at the top of easy bends and reduce the discharge of the siphon.

(2) Contrary to the opinions expressed by some earlier research workers, the studies indicate that the introduction of volutes in the funnel obstructs the flow in the siphon and does not hasten priming.

(3) Piezometric pressures at various points of the hydraulic models indicate the regions of maximum negative pressure. The experiments reveal that if these circular siphons are used as priming devices or pilot siphons, then the suction pipe should be connected between the throat of the pilot siphon where the negative pressure is maximum, and the dome of the main siphon which has to be primed, and not between the domes of the two siphons as done in the conventional practice.

(4) The optimum elevation for fixing the inlet of the deprimer has been found to be somewhat higher than the crest level and furthermore it was found desirable to cut the deprimer pipe at 45° to the horizontal at the inlet so that the area of the deprimer is exposed at an increasing rate from the top of the inlet.

(5) Due to the certainty of full flow, the improved model can be used without the necessity of exit submersion and priming devices like volutes or deflectors and the available head can be fully utilized. On the other hand, if exit has to be submerged for causing priming action, evidently, available head would not be fully utilized.

Chapter V deals with the three-dimensional electrical analogy for potential flow in the improved model. Previously only two-dimensional models of these siphons have been studied by others by electrical analogy, although it is incorrect to draw any conclusions from such studies since the flow is essentially three-dimensional. This was presumably due to the difficulty in making a three-dimensional electrical analogy model in which the boundary conditions could be truly simulated and also due to the experimental difficulty in probing the null points at different depths of the electrolyte. Moreover, the velocities at various points in the three-dimensional model cannot obviously be calculated on the basis of two dimensional flow net theory. In three-dimensional flow, the flow net theory becomes inapplicable except for axisymmetric models. The circular siphon has no axisymmetry due to the outlet bend. However, the writer taking advantage of the existence of the diametrical plane of symmetry, succeeded in making a three-dimensional model of the symmetrical half of the circular siphon and has obtained satisfactory results by the electrical analogy. The critical section or the region of lowest pressure has been determined by this method. The results confirm the trends observed in the hydraulic model.

Chapter VI deals with the Considerations in the hydraulic design of the improved type of circular siphon.

Chapter VII gives a summary of the conclusions.