The Indian Sugar Industry (1938 *Annual*). By M. P. Gandhi. (Gandhi & Co., Calcutta), 1938. Pp. 300. Price Rs. 2-4-0.

This publication like its predecessors by the same author, abounds in statistical information about the progress of Indian Sugar Industry during the year 1938. The data are presented alongside the corresponding figures for the previous years and enable the reader to make a thorough comparison.

The essential texts of the various Acts of the Government of India and the Provincial Governments of the U.P. and Bihar, relating to the protection and control of Sugar Industry are given in the beginning of this monograph. Following this is a compilation of 37 tables—Sugar Industry at a glance—containing numerous industrial data. This is a very useful and ready reference for the readers. In the end of this section the author has given an interesting forecast of Tariff Board's recommendations, the publication of which is expected shortly.

The main text is divided into two parts and contains a very detailed treatment of the various aspects of Indian Sugar Industry. The author has freely quoted from different authorities and has advanced his own views and arguments on the many questions relating to the industry and its problems.

Indian Sugar Industry has made rapid progress in the last five years during which period the country has been able to attain self-sufficiency in her sugar requirements. In fact, the white sugar production has just reached the country's needs for consumption and is raising problems of checking over production, and economic manufacture of sugar, to enable profitable exportation. This publication by Mr. M. P. Gandhi comes in very opportune, giving as it does a complete account of the industry's progress during these years.

The book is recommended for one and all interested in Sugar Industry

G. G. R.

The Design of Weirs on Permeable Foundations.*

THE design of weirs on permeable foundations has been thoroughly dealt with by Rai Bahadur A. N. Khosla, Dr. N. K. Bose, Dr. E. McKenzie Taylor and their colleagues in the present Publication No. 12 of the Central Board of Irrigation, India. Exhaustive investigations have been carried out by the authors, with the result that they are now able to present a fairly complete solution of the complex problem which is supported by data from prototypes in the field, models in the laboratory and by mathematical theory.

Until recently Bligh's Creep Theory was being adopted for designing weirs with component parts on sand or alluvial soil. This theory has been found to be defective from actual field observations and new formulæ have been evolved by the authors. The design of weirs on sand foundations which was hitherto based on assumption can now be worked out with exactness in a rational and scientific manner.

The publication consists of eleven chapters. Chapter I is mainly historical and traces the development of the science of subsoil hydraulics as related to weir design on permeable foundations from the earliest times to the present day. The earliest formula was given by H. D'Arcy for the flow of water through permeable solids in 1856 and the validity of the same was tested by Col. Clibborn in 1896. The investigations carried out by Col. Clibborn, Sir John Benton and others formed the first rational basis for the design of weirs on sand and they gave the idea of failure by undermining and uplift due to flow of water through the subsoil of the weir. Sir John Ottley and Thomas Higham developed from the results of experiments conducted by Col. Clibborn what is known as 'The hydraulic gradient theory' which came to be generally accepted in India. Bligh who originally believed that the stability of a weir depended on its weight, became subsequently converted to the hydraulic gradient theory and his enunciation of this theory is known as Bligh Creep Theory. This theory stated that the

length of the path of flow had the same effectiveness length for length, in reducing uplift pressures whether it was along a horizontal or a vertical line. Following Buckley, he assumed the percolation water to creep along the contact of the base profile of the weir with the subsoil losing head enroute, proportional to the length of its travel. He called the loss of head per unit length the ' Percolation gradient'. The importance of vertical cut-offs at the upstream and downstream ends was lost sight of by him. The actual pressures indicated by pipes inserted in the floors of some of the weirs disclosed great disparity between those observed and calculated by this theory.

Chapter II deals with the theory of seepage flow, D'Arcy's law and its extensions as obtained by Schlichter. It is shown in this chapter how Schlichter's equation agrees with the well-known Laplace equation, which governs the steady flow of heat and electricity through a conductor and of a perfect fluid. It is established that the problem of flow of water through the subsoil is analogous to that of the flow of a viscous fluid or that of electricity through a conductor. This discovery of the analogy has led to the solution of the various problems connected with seepage flow.

The fundamental differential equation is given by Laplace as :

$$\frac{\delta^2 p}{\delta x^2} + \frac{\delta^2 p}{\delta y^2} + \frac{\delta^2 p}{\delta z^2} = 0.$$

It is thus shown that in the problem of subsoil flow the determination of equipressure surfaces is identical with that of the equipotential surfaces in the problems of the steady flow of electric currents through conductors.

Chapter IV describes the experimental verification of the potential law applicable to the flow of water through permeable homogeneous subsoils by means of models. Experiments with both hydraulic and electric models prove that the flow net of equipressure and stream lines for any particular weir profile is independent of (1) class and structure of subsoil so long as it is homogeneous ; (2) scale or size of structure ; (3) temperature so long as it is uniform throughout the medium ; (4) applied head ; and (5) upstream and downstream water levels. Conclusions 3, 4 and 5 have been arrived at from a study of the pressure observations at the Panjnad Weir.

Chapter V describes the erection of pressure pipes in Khanki Weir, Panjnad Weir, etc. The study of pressures in the Panjnad Weir is stated to have been the first experiment of its kind in the world and it has been instrumental in furnishing the final solution to the complex problem of weir design on sand foundations. In this chapter, the location of pressure points, precautions to be taken in the erection of pressure pipes, the observations to be made and the instruments used are explained in detail.

The method of recording observations made, standard forms to be used, and plotting of values obtained in the form of graphs are also described.

Chapter VI is devoted to the comparison of results obtained from models of Panjnad Weir, Khanki Weir, Lloyd Barrage, Deg Escape Head, etc., and their prototypes. A large amount of data is presented to prove that models can reproduce exact field conditions and the results obtained from models can be accepted as a safe guide for the designing of weirs. It is also shown how the actual observed uplift pressures do not exceed 82 per cent. of the designed pressure and there is thus a factor of safety provided by nature. The effect of silt and scour at the upstream and downstream of pervious floors and the difference in temperature of the river water and the subsoil are discussed. Silt upstream will reduce uplift pressures and that downstream will increase them. Similarly scour upstream will increase uplift pressures and scour downstream will reduce them. The latter may however lead to dangerous conditions eventually.

Chapter VII deals with the mathematics of weir design. The determination of uplift pressures and exit gradients for a number of cases of floors with pile lines in different positions below the floors is worked out mathematically. A number of tables and charts for different values and conditions are given in detail. A summary of Mr. J. K. Malhotra's mathematical investigations of the subsoil flow under two standard forms of structures consisting of a single depressed floor without aprons and a pair of equal sheet piles placed at the heel and toe of a flush floor is appended to this chapter.

Chapter VIII discusses the question of exit gradients as related to weir design.

The failure of a weir on sand from a seepage flow can occur by (1) undermining of the subsoil and (2) uplift due to pressure under the floor being in excess of the weight on the floor. The failure from the undermining of the subsoil which usually starts from the tail end of the work is the most common. Its causes and measures to prevent such failure are therefore discussed in detail. The investigations prove the absolute necessity of having some depth of piles or vertical cut-off at the tail end.

One general feature which is noticeable in all the experiments is that the insertion of a pile anywhere results in heading up or increase of pressure upstream and a reduction downstream, the increase or reduction being maximum at the pile and decreasing rapidly farther off. The main influence is confined to a radius equal to the depth of the pile. At twice the radius the influence becomes negligible.

The last chapter discusses principles governing the design of weirs in relation to the flow of water over the surface. The subject of surface flow is still lacking in researches and the design is based on empirical formulæ which may require to be modified in the light of investigations to be conducted in future. In subsurface flow, the chief factors which govern the design of weirs are (1) uplift pressures and (2) exit gradients. But in the case of surface flow the additional factor of dynamic impact has to be considered. The design in this respect will depend upon (1) the afflux, (2) the changes in the regime of river, (3) the discharge per foot run, (4) flood scour, and (5) the position and depth of the trough of the standing wave. The material discussed in this chapter represents the accumulated experience in the field supplemented by a limited amount of experimental investigations. The great need for further research in regard to surface flow is emphasised.

The book contains a large number of tables, graphs, diagrams and photographs of experiments which are highly interesting and useful in following the theoretical calculations. The authors and their colleagues deserve to be highly commended for their excellent work.   V. G.

OBITUARY.
Pandit Hemraj.

PANDIT HEMRAJ, Principal, Dyal Singh College, Lahore, whose untimely death is being mourned in all circles, was born in Daffar, a village in the Hoshiarpur District of the Panjab, towards the end of the year 1886. His father Pandit Ganga Ram who survives him is a poor Brahmin. It was under hard circumstances, therefore, that Pandit Hemraj received his education. He passed his middle school examination from the S.D. School, in 1903, and his matriculation from the Government High School, Hoshiarpur, in 1905. He passed his B.A. and M.A. examinations from the D.A.V. College, Lahore, with distinction, standing first in the first class in the M.A. examination in 1912. Shortly after passing his M.A., Pandit Ji was appointed in October 1912, an Assistant Professor of Mathematics in the Dyal Singh College, Lahore. Pandit Ji's work thus came to the notice of the Panjab Government and Sir John Maynard, the then Vice-Chancellor of the Panjab University, moved the University to offer him a scholarship to go abroad for higher studies. The offer was not accepted for reasons of health. By hard work Pandit Ji rose to the Principalship of the College in 1921, and served it ably till the time of his death on the night of the 12th November 1938. His death has left a void in the academic life of the Panjab University.

HANSRAJ GUPTA.