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IRRIGATION OUTLETS

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The success of an irrigation enterprise would depend upon the success with which irrigation water could be supplied whenever needed by crops. There are three main methods i.e. Sub surface irrigation, Spray irrigation and Surface irrigation. An outlet is a device at the head of a watercourse to deliver water from the canal. In Punjab about 40,000 outlets irrigate an area of about 14 million acres.

The principle underlying the distribution of water envisages that each cultivator has a uniform proportion of area irrigated in his irrigable area. There are various methods of distribution of water. Continuous flow system of irrigation is only useful to big farmers. In intermitant flow system, the entire discharge from an outlet is taken by different farmers in turn, the turns being fixed in proportion to the irrigated areas owned by each individual. This system is conducive to economical use of water. For Punjab canals, the distribution and supply of water on demand is impracticable. There is generally no manual control on working of outlets. The internal distribution of water on the farm is managed by cultivators themselves. The assessment of water through outlet by measuring volume is not practicable due to costly measuring devices and silt and debris in water which could block the measuring device. In Punjab, the system of assessment is based on the acreage matured, and on water rates difference for different crops.

There are three main sources of irrigation supplies; rivers, reservoirs and open wells/tubewells. When the source of water is the river, water supply is limited to availability at a particular time. The irrigation supplies may be made in three ways;

(i) By continuously running the various channels with their share of the available supplies.

(ii) By running the big channels continuously with their share and the small channels in rotation.

(iii) By giving authorised full supply discharge to each distributary system in rotation.

In actual practice the procedure adopted is a combination of first and third method.

A properly functioning outlet must be temper proof with low cost, should draw fair share of silt and should work efficiently with a small working head also. The optimum capacity of an outlet should be the discharge which the cultivators can handle efficiently and also that the absorption losses in the water course and in the field are minimum. It has been found that a 2 cusecs outlet is generally the best for the cultivators in Punjab who irrigate in fields of about 1/2 acre size.

Previously temporary outlets were fixed. An earthen ware pipe of 6" standard size was allowed for 100 acres of annual irrigation. Different water allowances were fixed for different areas. The duty of one cusecs varied from 275 to 457 acres. Both rectangular and pipe outlets were in use. All outlets were closed with wooden flaps. In those days tatiling of channel and tatiling of outlets on the same channel was a normal practice. The size of outlets was changed according to whether the area irrigated was in excess or less than the prescribed proportion of the commanded area. The questions raised include setting and geometry of outlet, size of barrel, method of closing the orifice, and when a permanent outlet should be built.

There has been further development in design, manufacture and management of outlets since then. The location of outlet was fixed at the heighest point with reference to adjacent commanded area. The size was fixed on the basis of normal full supply factor ranging from 250 to 300 acres. Many officers worked to obtain modular or semi modular conditions on the outlets. The tatiling of outlets is regarded as an

inefficient working of the distribution system. However remodelling of outlets in Punjab is still a problem.

Pipe outlet was adopted in Punjab for the first time on the Chenab canal. It consists of steel or cast iron pipe. Adjustability is obtained by putting the pipe of a larger size and by fitting it with a reducing socket. The pipe outlet set at bed level draws a fair share of silt. It can pass the required discharge with a small working head of even 0.1 ft. Scratchley outlet is a pipe outlet which opens into a cistern 2 to 3 ft square. Pipe outlet behave as nonmodular under submerged condition, but can be designed to act as semi modular outlet if free fall orifice conditions are secured. In 1928 a standing wave pipe outlet was developed. A rateable semi module was also developed known as Kennedy gauge outlet. This outlet could be easily tempered with due to its peculiar structure consisting of a vent pipe. The development process continued. Harvey Stoddard improved irrigation outlet consisted of an adjustable orifice connected by rectangular masonary pipe to a narrow long crested weir, which discharged into a flume. Its minimum modular head was in the range of 15% to 20% of the depth over the weir crest.

The open flume outlet is a development of the idea underlying the Harvey outlet. It consists of a smooth weir with a throat constricted sufficiently to ensure a velocity above the critical, with an expanding flume at the outfall to obtain maximum recover of head. It is not easily adjustable. Proportionality can be secured by keeping the crest of the outlet at 0.7 of the depth of the channel. The minimum modular head lied in the range of 10% to 20% of the head above the crest. Various types of these outlets were developed which include Crumps open flume, Haighs and Sharmas' modified open flume, Jamrao type open flume.

An orifice semi module is an orifice provided with an expanding flume. The critical velocity is exceeded in the orifice and thus discharge is independent of water level in the watercourse. Adjustability is secured by raising or lowering the roof block. Proportionality is secured when the bottom of roof block is submerged below the full supply level by 3/10 of the depth of water in the channel. The experience on channel fitted with proportional orifice semi module shows that the channel is generally silted up. A modification was made in this type of outlet by

lowering the setting of outlet close to the channel bed which improved the silt draw and made it more rigid.

It was observed that it was not possible to place the crest of an open flume or an orifice semi module too close to the bed on account of practical difficulties and limitations of available working head. Various devices such as bend outlet, Haighs silt-extracting S.M.M.O and Gunns' nozzle outlet were developed to extract more silt from the channel. Pipe cum semi module has an advantage over other devices as control of silt induction can be achieved.

The earlier attempts to design a module were made in Europe. A series of modules with moving parts were designed in India which include Vishesvarya self acting module, Kennedy outlet module, Wilkins module, Kent 'O' type module and Khanna's auto adjusting orifice distributor. These outlets have little practical utility on a large scale. Some of them are very expensive and not simple to design and construct. In modules without moving parts such as Gibb's, Khanna's O.S.M. and Ghafoors' the constant discharge is automatically regulated by the velocity of water itself. The Gibbs' module was tried in 1909 and it was observed that it was easily tempered with, was costly and had low silt drawing capacity. The other modules were still in experimental stage. To measure the volume of irrigation water through outlet Dethidge meter, Recorder cum semimodule and Patwari cum semi module were tried in the field.

In irrigation channels the discharges and the water levels vary from time to time. Such variations in discharge require proportional outlets. The needs of reclamation or seasonal variation in slope require the use of outlets of low flexibility. Rotational running presumes the use of outlets of high flexibility. Lindlay pointed out in 1923 that proportional distribution is neither necessary nor desirable. He concluded that semi modules with low flexibility can satisfy the needs of the cultivators.

It is difficult to satisfy the opposing conditions of small loss of head in the outlet and efficient silt conduction. Sharma conducted experiments on various types of outlets which showed that a silt conduction of 110 to 115% was obtained by;

(i) Crumps, O.S.M set at 9/10th

(ii) Sharmas' O.S.M. set at 8/10th

(iii) Crumps open flume set at bed level

(iv) Sharmas' modified open flume set at 7/10th.

The available working head can be increased by exclusion of high areas, shifting the site upstream of control point, raising of full supply level and desilting of water courses.

The modules should be used in the case of direct outlets taking off from a branch canal. Non modular outlets should be avoided as far as possible, but where available working head is limited Scratchley type outlet may be used. Wherever possible outlets should be clustered above a control point. The outlet at the tail cluster should be of openflume type. All other outlets should have as low a flexibility as possible. This can be secured by A.O.S.M set at bed level or open flumes fitted with roof block. Wherever the section of bank is heavy and other outlets can not be set at bed level, the pipe cum semi module should be used. On new channels the use of temporary pipe outlet would give definite data on which final construction of outlets could be carried out.

Note :

Paper No. 264 appears in the Proceeding of Engineering Congress 1944 Vol. XXXII at pages 1 to 98. This paper consists of 7 Chapters and five appendices. It has 20 Plates showing the details of various outlets. Discussions are recorded at pages 99 to 125. Interested reader may refer to the original paper.