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Remodelling of irrigation channels was carried out during the years 1927 to 1938 in the Lower Jehlum Canal Circle and East Circle of the Lower Chenab Canal, because of unsatisfactory distribution of irrigation water. In the past, to overcome the tail shortage the only remedy was to adjust the outlets without paying attention to the hydraulic condition of the channel. Now it is the time to lay down clear and definite policy for remodelling on each canal and it should be reviewed periodically when experience shows that it is defective.

In Lower Jehlum Canal Circle the remodelling of Mithalak distributary and in Lower Chenab Canal East Circle the remodelling of Mungi, Awagat and Kheowala distributary was attempted prior to 1934. Mithalak distributary offtakes from Northern Branch whereas the latter three channels offtake from Lower Gugera Branch. The channels had generally silted up from time to time and their slopes were steepened. The headregulator crests wese raised and construction of raised cill was carried out in some cases to prevent excessive coarse silt entry as the original crests were at the bed of the parent channel. This remedial measure failed and the channels continued to silt up. From time to time outlets were remodelled and the orifice outlets were replaced by kennedy Gauge outlets and at a latter stage Mr. Crumps A.P.M. outlets were adopted. The channels continued to give trouble resulting in rise in water level at head and at tail shortage. Also meter flumes and control points were introduced to regulate the flow and improve the discharge of outlets.

In 1934 remodelling of Mithlak distributary was taken up to evolve a strategy for remodelling of other channels. A detailed hydraulic survey of the channel showed that the channel slopes were steep and it had widened exceptionally in all the reaches. It was observed that main cause of trouble was the hydraulically defective head regulator which drew excessive coarse silt due to formation of eddies in the pocket in front of the head regulator. The headregulator was remodelled and the channel bed regraded to slightly flatter slopes as steeper slopes required abolishing of control points which was not considered desirable. The channel was artificially forced to conform to the new section by forming berms with hanging brushes. The design of control points was modified with the provision of broad crested weirs. Mr. Sharmas modified design of A.P.M. outlet with its setting close to the bed level was adopted to increase the silt induction capacity of outlets.

Hydraulic survey of Mungi distributary was carried out and Longitudinal section of the channel was prepared indicating hydraulic data of the channel and outlets. The headregulator of the channel was ineffective to control excessive silt entry. A skimmer already constructed failed to serve the purpose due to silt deposit in front of exit tunnel because of obstruction due to King's Vane. The head regulator was remodelled to control the silt entry. To remodel the channel it was planned to construct two control points consisting of broad crested weirs which required flattening of slopes. This proposal was found unworkable. The outlets were remodelled by adopting Sharma's modified type A.P.M. outlet with its setting close to bed of the channel.

Remodelling of Awagat distributary was planned after detailed hydraulic survey. It was observed that channel section was abnormally wide and shallow and the outlets were not drawing equitable share of silt. It was planned to regrade the channel to slightly flatter slopes as the headregulator was to be remodelled. Sharma's design of modified A.P.M. outlet was adopted to remodel the outlets based on their satisfactory silt drawing capacity. The section was tightended with longitudinal bushing. The distributary has operated satisfactorily and it shows that in some cases flat slopes may be adopted provided head regulator is remodelled in a way to prevent excessive coarse silt entry.

The hydraulic data of Kheowala distributary shows that the channel could not draw authorised discharge due to silting. The remodelling of the channel was planned by redesign of headregulator and introduction of meter flume and a control point. It was anticipated that the channel would work with flatter slopes as compared to existing slopes. Sharma's A.P.M. outlets were adopted to remodel the outlets. During the operation of the channel it was observed that there existed slight silting tendency and therefore steep slopes were adopted. The remodelling experience of this channel shows that the policy of flattening of slopes did not work in this case and provision of control point for such a short channel was unnecesary.

The remodelling of channel prior to 1934 failed because the proposed remedial measures for remodelling of head regulators were not able to prevent eddy formation and also the proposed skimmer and advanced cill intensified the trouble., The replacement of old type outlets with Kennedy Gauge outlets did not improve the condition to overcome tail shortage. The main cause of failure was the attempt to deal with one aspect of trouble only. If the history of the channel had been studied and complete remodelling carried out, success would have been attained in many cases.

The planning of remodelling of a channel involves hydraulic survey which requires establishing reliable bench marks for levelling survey. The longitudinal section and cross-sections are plotted. The study of previous history of the channel provides useful information to prepare a strategy for remodelling. The remodelling of masonary structures such as headregulator is carried out first and the channel is regraded to proposed slopes. The channel is allowed to work for a full crop period before remodelling the outlets, even though it may become necessary to run the channel with higher discharges. The crest level of the outlets is set as low as possible to increase their silt induction. However in some cases there will be constraint to this setting depending upon the availability of the working head. It is necesary to inspect the outlets and ascertain the problems of irrigators to evolve proper remedial measures. The remodelling scheme should include all works that are necessary to make the channel work efficiently.

Raising and strengthening of banks should be based upon discharge of the channel. Earthwork should be measured by bank measurements.

Strong banks and liberal berms should be provided. Artificial construction of the channel should only be restored when the section is abnormally wide. Hanging bushing spurs have not been found to be advisable and the only suitable method of berm formation is by longitudinal bushing. Silt clearance of channel is to performed to the full existing bed width. If a channel is wider than the designed bed width it must not be silt cleared to the designed bed level, otherwise the water levels in the channel would be lowered. After remodelling of the channel there may be berm formation at tail during the summer season, but this does not mean failure as the normal water levels can be restored by clearing the tail. The monitoring of outlet is to be done by observing their discharge by specially designed portable flumes. In some cases the outlets would not draw their authorised discharge due to lowering of water levels and therefore in such cases auxillary pipes should be provide to cater for the demands of irrigators.

The suggested policy for remodelling on the Lower Chenab Canal system is based on remodelling experience and the canal operation. The full supply level of as many channels as possible in a system should be fixed at a definite level and maintained at this level by silt clearance. The water levels should not be raised unnecessarily as it will result in extra expenditure on raising of banks. Command of high patches of area with further raising of water level should not be allowed in any case. This plicy will reduce the expenditure on remodelling of outlets. In some cases the channel may show scouring trend and this problem can be tackled by introduction of control points. This policy might be adopted on the Lower Jhelum and Lower Bari Doab Canals after examining the local conditions.

As a general principle every distributary should be made to draw as much coarse silt as it can take without interfering with its regime. Drastic silt exclusion with skimmer headregulator should only be permitted in exeptional cases. The experience in the West Circle of the Lower Chenab Canal shows that the tail distributaries of the Jhang Branch Upper have silted badly. Open flume type headregulators have proved most satisfactory as most of the channels that have been remodelled are now in fairly stable regime.

The head regulators for Awagat and Kheowala distributaries were designed in such a way that the mean velocity in the flume of the regulator would be approximately equal to or slightly lesser than the mean velocity in the side segment of the parent channel. The gate is placed on the distributary side of the bridge so that the high velocity under the gate should have no effect on the velocity at the mouth of flume. The experiments were conducted to ascertain the distribution of silt in the regulators bays which showed that medium silt was distributed uniformly whereas coarse silt was less near the sides than the centre. Further research on model experiment would give us information about the silt drawing capacity of head regulators. Meterflumes and control points should be installed at suitable location to monitor and regulate the flow. An appropriate type of structure is broad crested flume which requires less working head for its modularity. Its main advantage is formation of standing wave near the crest and wave action downstream is reduced to a minimum. Its discharge coefficient varies from 2.95 to 3.05 depending upon head above the flume and its geometric profile.

The hydraulic data of the channel and outlets should be prepared on longitudinal section with a horizontal and vertical scale of 1" = 1 mile and 1/50 respectively. Existing and proposed water levels and bed levels should be indicated in different colours. The Superintending Engineer of the circle should exercise his control in regard to timely observations and correct methodology and record keeping of hydraulic data of the channel and outlets.