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“The Chenab Weir.”

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(*Abstract.*)

THE Chenab Canal, Punjab, was opened in July, 1887, but on account of excessive silting of the first few miles during the flood season, it was found impossible to obtain enough water for irrigation purposes; and, in consequence, a project for the conversion of this “inundation” canal into a perennial one, with a weir and permanent head-works, was prepared in 1889 and was sanctioned by the Government in January, 1890. The site of the works was at Khanké, 10 miles below Wazirabad. The alignment of the weir makes an angle of 75° with the axis of the river, and the water-way is 4,000 lineal feet. The weir is divided by piers, 10 feet wide, into 8 spans or segments of about 500 feet in length; and on the crest are fastened cast-iron hinge-blocks, held down by bolts carrying wrought-iron falling-shutters, 6 feet high and 3 feet wide. These can be raised by a crane travelling on a 4-foot gauge railway, immediately below the shutters, and can be dropped from the abutments and piers by means of a winch and a rope-and-ball.

The falling-shutters are of novel construction, and the contrivances for raising, holding and dropping them have been arranged by the Author. The cost of the shutters erected on the weir is only 31·4 rupees per foot run. Wooden strips at the sides of the shutters project about $\frac{1}{2}$ inch beyond the angle-bars, and the shutters are prevented from touching one another by a saw-cut between them—a feature worthy of attention.

The railway on which the crane travels is continuous along the weir, and on each pier and on the abutments small crab-winchies are fixed for winding up the 1-inch flexible steel-wire ropes by means of which the shutters are dropped. The piers extend upstream in stone groynes about 200 feet long, and down-stream in masonry walls 50 feet long, with masonry groynes 120 feet long in continuation of them. By this means the river is prevented from

flowing over the weir in oblique currents to any great extent. At each abutment shelters for the cranes are provided. When the river is too high for the cranes on the railway to be used, the shutters are raised from boats with cranes projecting over the stern, dropped down from moorings above the weir. It is obvious that the weir, being divided into sections of which the shutters can be worked independently, gives great control over the river.

In order to effect easy communication with the piers, and across the weir in times of flood, a steel-wire rope carrying a cradle has been erected. The rope is $4\frac{1}{2}$ inches in girth, continuous over the standards throughout the length of the weir and under-sluices; whilst at each end-standard it passes over wheels and is strained by weights of 8 tons. The effect of this arrangement is that when the cradle is passing over a span, the tension of the rope remains nearly constant, but the dip increases in proportion to the weight of the cradle and its occupants; whilst in an unloaded span the dip is only about 5 feet, the levels being arranged so as not to interfere with passing boats. The level adopted for the crest of the weir is supposed to be nearly the average level of the river-bed, and when the shutters are down there is usually little or no heading-up of the river by the weir.

In order to drop similar falling-shutters, previously used on Indian weirs, it was necessary for a man to go out and knock them down with a hammer—a method that was always inconvenient and often dangerous, especially when the work had to be done during the night; but if the water went over the top of the Chenab weir, it would in no way interfere with the process of dropping the shutters.

The Author has devised the arrangement shown in *Figs. 1*, by means of which falling-shutters can be dropped from any fixed point by a rope or chain having a heavy ball at the end. A forked trigger fitting into a slot in a hook holds the shutter against pressure in front of it. The fork at the upper end of the trigger sustains a 1-inch flexible steel-wire rope, of sufficient length to reach across one of the segments of the weir, and continuously supported on these forks from the winch which is used to drop the shutters; a steel ball is attached to the end of the rope, so that when the latter is wound up by a winch the trigger revolves round the bolt, the tongue leaves the slot in the hook, the ball slides out of the fork, and the shutter falls. When the ball leaves the fork, it hangs loosely at the end of the rope, until, by winding up the rope, the ball is brought up to the next fork in which the rope rests, and another shutter is then dropped as before, and so

on. The arrangement is such that when the rope is being pulled for the purpose of dropping a shutter, the ball cannot slide out of the fork till the tongue of the trigger is clear of the hook. The design provides that the trigger shall be capable of being worked from either side, so that when the shutters are being dropped from a pier, the same winch suffices to drop them in two adjacent bays. If it is desired to drop, say, every second or third shutter, it is

Figs. 1.

only necessary to remove the rope from the intermediate forks. This arrangement has worked perfectly on the Chenab weir, where the shutters are dropped at a distance of 520 feet from the winch ; but there is no reason why the arrangement should not work at greater distances.

In all other cases in which such hooks and bars have been used for supporting falling-shutters, as far as the Author knows, there

has been no arrangement to guide the hook to the hole in the shutter, through which it must pass before the trigger-tongue can be put home; and, in the case of weirs, the work has to be done by a man standing in or diving into the water on the up-stream side of the shutter. The automatic guide with the stop-hinge does away with the necessity for this, as the hook is forced to travel up and down the face of the shutter as the latter rises and falls; so that when the shutter rises to its final position, the hook must have passed through the hole in the shutter, and must be in position to receive the tongue of the trigger, which is then put home by an attendant. The hook is fastened to the supporting-bar by a hinged joint—a pin projecting on both sides, under the top flanges of the guide, so that it cannot be removed except by sliding it out at the lower end. It has a stop-hinge at the back, forming part of the above-mentioned hinged joint, which fixes it in its true position to enter the hole in the shutter at the top of the guide; the angle between the top of the hook and the top of the hole in the shutter is such that the surfaces easily slide on one another, so that when the shutter rises and by means of the stop-hinge forces these surfaces into contact, the hook glides through the hole in the shutter to its position.

The guide is carried down to the bottom of the Chenab-weir shutters; but if it is considered advisable in any case to allow the head of the tie-bar to leave the guide when the shutter has fallen through any particular angle, the sides of the guide should be curved laterally, so as to release the cross-pin at the desired point.

The upper part of the jib of the crane used is horizontal and is capable of turning over the tops of the shutters and also of passing under the iron roofs which span the openings in the piers through which the railway passes. As it is intended to house the cranes if necessary in these openings during floods, or when not in use, the jibs have been designed to fold back, so as to permit this. When lifting a shutter by the crane, the jib is turned up-stream at an angle of about 45° and fixed in that position, and the crane is moved along the railway till the end of the jib is opposite to the centre of the shutter to be raised. The hook of the tackle is fastened to the sling of the shutter, which is then raised by winding up the tackle. It was feared that the twisting action thus brought to bear on the crane would cause the wheels to mount the rails, but this has never happened, the weight of the crane preventing any such occurrence; it would be easy, however, to clip the crane to the rails if necessary. The

guide has worked in a most satisfactory manner, although at first it was feared that it might become clogged.

The construction of the weir was commenced in January, 1891, and was completed in February, 1892, the works being carried out under the direction of the Author.

The Paper is illustrated by a number of drawings and photographs, from a selection of which the *Figs.* in the text have been prepared.