WATERCOURSE LINING WITH RCC SLABS

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Specially designed RCC slabs were fabricated and tested to line the watercourses in a trapezoidal shape.The RCC watercourse sections were found to be about 30% less expensive as compared to the watercourse section lined with brick masonry in rectangular shape using 23 cm thick wall. RCC watercourse lining technique is more preferable at places where good quality bricks are not available and are to be transported from long distances.

INTRODUCTION

Evaluation of the existing watercourse conveyance losses has shown that about 40% of the water diverted into the system is lost before reaching the farm gate (Lowdermilk *et al.,* 1978). Reuse *et al.* (1975) established that of the different watercourse improvement techniques, earthen improvement reduces the delivery losses by about 50%. However, the said reduction is only short-lived as the improved watercourse start leaking as before due to lack of maintenance and repair of control structures. Brick masonary watercourse lining technique in a rectangular design (23 cm thick walls) mostly used for lining the watercourse sections under the OFWM projects is highly cost intensive. As such only 15% length of watercourse in fresh groundwater and 30% length in saline groundwater are lined (Anonymous, 1985).

In view of the rising cost of construction materials and increased pressure of farmers to increase the length of lining, there was a great need to develop alternate low cost lining techniques that could be used to line longer lengths of watercourses, controlling seepage losses from the watercourses effectively at the same time. Studies were initiated for testing specially designed RCC slabs for lining watercourses. The RCC slabs were designed and fabricated at the campus and used for lining watercourses on the university watercourses as well as farmer's watercourses to evaluate their performance with regard to their cost effectiveness to control seepage losses and convenience of installing these RCC watercourse sections. These results were compared with those of masonry watercourse lining technique to make final recommendations.

MATERIALS AND METHODS

Structural design and cross section: RCC slabs each one meter long both for the bed as well as for sides were designed keeping in view the earth pressure of backfill. The side slabs were fabricated in two sizes, 52 cm and 62 cm wide. Thickness of the slabs was 5 cm. Ribs were provided longitudinally and transversely at every 10 cm to reduce the weight of the slabs.

These precast slabs were assembled to prepare 1 m long watercourse section. In each case the section formed had 30 cm wide bottom. However, the total depth and width of the section was 60 cm and 61 cm respectively in case of bigger slabs. While these were 50 cm and 58.5 cm in case of small side slabs. However, depending upon the available flow rate and slope, the required size of the side slabs can be selected.

The bed slab had two builtin V-shaped grooves, on each at the outer edge. The lower wedge shaped end of the side slab fitted in this groove. On each side of the side slab a groove was also provided, so that when two side slabs were assembled a circular slot was formed in which concrete was poured which held the two slabs tightly (Fig. 1). The bed slab had a male and female end which facilitates the joining of the bed slabs by placing a thin layer of cement-sand mortar. These slabs were fabricated with the help of metallic moulds using 1:2:4 concrete mix and the calculated quantity of reinforcement in accordance with earth pressure of backfill (Table 1).

Method of installation: The old watercourse was demolished and the bed was compacted to the designed grade. The bed slabs were placed on the bed and aligned using a mason's thread. For this purpose, a mark was provided in the centre of bed slab at both ends which should coincide with the thread stretched in the centre of watercourse bed. During laying the bed slabs it was ascertained that these were level longitudinally and transversely. This was accomplished with the help of a spirit level. After the bed slabs were aligned, thin layer of cement-sand mortar was provided as a joint in the space between two slabs.

The side slabs were fixed in such a way that the centre of each side should come at the joint of the two bed slabs thus providing an added strength to the lining. To begin with, two slabs one at the beginning and the other at the other end of the section, were fixed. A thread was stretched between these two slabs to maintain the proper alignment during fixing the rest of the side slabs of one side. This method was used to fix the slabs on the other side also. Concrete was poured in the circular slots formed between two side slabs. After this, earth was backfilled to provide a pad along the lined section.

RESULTS AND DISCUSSION

Since the length of each slab is 1 m, therefore, three slabs (one bed and two side slabs) are required to line one meter long watercourse section. The cost per meter has been worked out to be Rs. 125.00. The details regarding cost elements needed for fabrication are presented in Table 2.

As regards labour and material costs for installation of these slabs, it has been studied to be about 10-15 Rs. m^{-1}. It means that the total cost of RCC slab lining comes to Rs. 135.00-140.00 per linear meter which is about 30% less expansive as compared to conventional lining technique (costing Rs. 165 and Rs. 28) for material and labour respectively per linear meter (Khan, 1988).

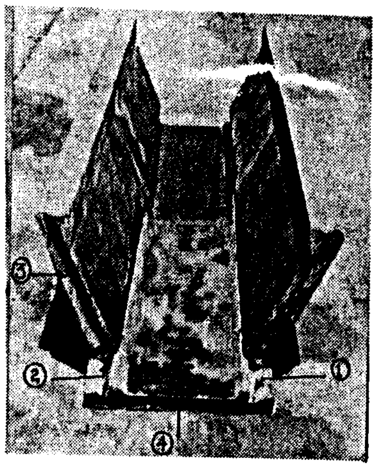
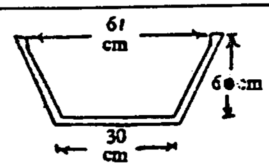
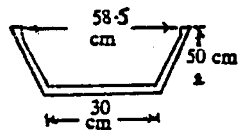


Fig. 1. RCC slabs watercourse section.
1. V-shaped groove of the bed slab.
2. Wedge shaped end of the side slab.
3. Side groove of the side slab.
4. Male end of the bed slab.

Table 1. Thickness of the side-slab and reinforcement requirements based on the earth pressure of the backfill

Size of side-slab cm	Cross-section	Earth pressure* kg/30 cm run	Moment kg-cm	Thickness of slab cm	Effective depth (di) cm	Reinforcement	
						Lengthwise	Widthwise
62 x 100		472	9587	7.5	5	5 bars of 9.5 mm size @ 12.5 cm c/c	4 bars of 6.3 mm size @ 25 cm c/c
52 x 100		389	6581	6.35	4	4 bars of 9.5 mm size @ 12.5 mm c/c	3 bars of 6.3 mm size @ 30 cm c/c

*Based on the Rankine's formula, angle of response 68°, and top width of the backfill 90 cm.

Table 2. Material and labour cost for fabricating RCC slabs (one bed, two side slabs) to line one meter long watercourse section

Material	Quantity	Rate	Cost*
Cement	0.6 bags	Rs. 86/bag	Rs. 52.00
Sand	1.5 cu. ft.	Rs. 1.5/cu. ft.	Rs. 2.25
Crush	3.0 cu. ft.	Rs. 4.00/cu. ft.	Rs. 12.00
Iron-bar	4.0 kg	Rs. 9.00/kg	Rs. 36.00
Labour	6 man-hours	Rs. 3.75/ma-hr.	Rs. 23.00
Total			Rs. 125.00

*Price index for the year 1989-90.

Collection of hydraulic data on the lined watercourse sections: The performance of the lined watercourse sections located at different places was monitored immediately after construction and then at interval of six months for three years. Data on seepage loss rates and Manning's roughness coefficient were collected.

Seepage losses were calculated according to Kemper (1983) ponding method. In case of brick masonry watercourse lining in trapezoidal design located at the University of Agriculture, Faisalabad as well as at the Postgraduate Agriculture Research Station (PARS), the seepage loss was found to be 0.38 litre per square foot per hour after six months of construction which did not differ much with the value found immediately after construction (0.39 litre per square foot per hour). The value of roughness coefficient was found to be 0.0139.

In case of watercourse section lined with precast slabs (three piece section) located at the University Campus, the seepage loss rate was almost the same as found immediately after construction (0.196 litre per square foot per hour), while the value of roughness coefficient was found to be 0.0135 six months after construction. In case of RCC slab lining technique, the seepage loss is about 48% less than the brick masonry trapezoidal technique. The value of roughness coefficient in both cases is almost the same.

REFERENCES

Anonymous. 1985. Feasibility studies for On-Farm Water Management Phase-II, NESPAK.

Khan, H.U. and A. Hafeez. 1988. Evaluation of Methods of Watercourse Construction in Pakistan. Mona Reclamation and Experimental Project, WAPDA and University of Idaho/USAID, Lahore, Pakistan.

Kemper, W.D. 1983. Methods of measuring seepage rates. Diagnostic Analysis of Irrigation System: Vol. 2. Evaluation Techniques, Water Management Synthesis Project, University Service Centre, Colorado Stet University, Fort Collins, Colorado, USA.

Lowdermilk, M.K., A.C. Early and D.M. Freeman. 1978. Farm irrigation constraints and farmers response-comprehensive field survey in Pakistan. Water Management Technical Report No. 48, Colorado State University, Fort Collins, Colorado, USA.

Reuse, J.O., G.U. Skogerboe and D.J. Merry. 1975. Water management programme to improve agricultural productivity in Pakistan. Technical Report No. 42, Colorado State University, Fort Collins, Colorado, USA.