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Bonding of soil and of sediment cleaned from channels by cement into blocks for lining irrigation channels

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Abstract

Water diverted from rivers to canals and then to fields brings along a heavy sediment load. According to estimates, the elevation of irrigated fields in the Indus Basin has increased up to 8 cm due to deposition of sediment from irrigation water. The deposition of sediment in the canals, distributaries and watercourses is a common concern. Each year during the winter, the canals are closed for desilting the conveyance system. Sediment deposited in the farmer-managed watercourses is piled along the watercourse banks, which takes fertile land out of production. This study was conducted to evaluate the possibilities of preparing cement blocks with soils and with sediments removed from the watercourses and using them in low cost linings to decrease losses from watercourses. Soil–cement and sediment–cement blocks were prepared, and tested for strength, durability and ability to reduce losses from watercourses. Compositions of the soil and of the sediments removed from the channels were determined. Blocks mortared into walls lining the sides of these channels reduced losses to less than 20% of losses in unlined old channels. Plastering the inside of these walls reduced water losses to less than 1% of the losses occurring in old unlined channels. Sediment–cement blocks were easier to make and they develop greater strength than soil–cement

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blocks. Cost of channel lining, using these blocks, appears to be about 2/3 of costs using fired brick masonry.

Keywords: Indus basin; Sediment–cement blocks; Soil–cement blocks; Watercourses; Losses

1. Introduction

Water is a limiting factor for crop production in Pakistan. Most of the water collected from the catchments of the Indus River and its tributaries is diverted to canals, which carry it to the irrigated areas in the Indus Basin. However, most of this water is lost as it seeps out of the farmer operated and maintained channels, which carry it from the canals to the farmers' fields. When new channels are constructed with banks made of compacted subsoil, the losses can commonly be reduced to less than 20% of their average value (e.g. Kahlown and Kemper, 2004). However, as vegetation covers these banks, with roots penetrating the compacted soil, the dying roots provide food to earthworms, which riddle the banks with small holes. Moles and other animals feed on the roots and on the worms and create larger holes, accelerating water loss. These invasions of compacted banks can take several years if the banks are initially made of subsoil low in organic matter. However, there is a need for permanent solution of this problem. Concrete and masonry can be sufficiently strong to resist such invasions (e.g. Kahlown and Kemper, in press). However, concrete is expensive because the Indus Basin is so flat that gravel size rock has not been carried into most of the basin by the rivers, and gravel for concrete must be hauled long distances. Firing of brick requires a large amount of energy, which is also relatively expensive in this area where there is no local source of coal or other forms of hydrocarbon fuel.

Soil–cement blocks were suggested, as a possible low cost alternative to concrete and fired brick, for lining watercourses. The cement, which goes into these blocks at 1:6 or 1:8 ratios, is still fairly expensive but the cement producing facilities of the nation have grown to match the demand in other sectors and dependable cement supplies are now available for the agricultural sector. Simple hand operated presses have been developed for compressing loose soil–cement mixes into blocks, which are sufficiently cohesive to be moved and cured by moistening and drying until they develop the needed strength. Mortaring such blocks into place as lining in a channel, which is used for only part of a week and is dry for the remainder of the week, allows the curing and strengthening process to continue. Other positive arguments, for on-site manufacturing of soil–cement blocks for channel lining are low transportation and labor costs. Soil, the main component, is generally available on site. There are several seasons in the year, when there is scarce work and, consequently, the labor costs can be minimal.

2. Objectives

i. To evaluate the strength, and feasibility of on site production of soil–cement blocks.
ii. To evaluate the rate of seepage from farm channels constructed with such blocks, with and without plastering on the insides.