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Kunal Dhadse
B. tech, Civil Engineering,
SRM University, Tamil Nadu,
India

Shubham Bhatt
B. tech, Civil Engineering,
SRM University, Tamil Nadu,
India

Manan Sachdeva
B. tech, Civil Engineering,
SRM University, Tamil Nadu,
India

Manasjyoti Das
B. tech, Civil Engineering,
SRM University, Tamil Nadu,
India

Correspondence:
Kunal Dhadse
B. tech, Civil Engineering,
SRM University, Tamil Nadu,
India

Structural design for canal ways for coastal cities

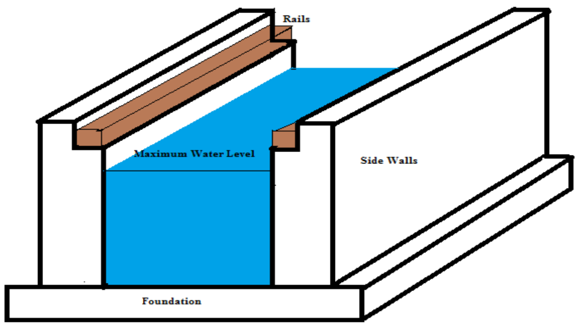
Kunal Dhadse, Shubham Bhatt, Manan Sachdeva, Manasjyoti Das

Abstract
In the world of transportation engineering there are five ways of transportation, for goods and for man. This paper is focused on introducing a sixth way of transportation that is different from Roadways, Rail Ways Airways, Waterways and tube ways. It is slightly related to the waterways of transportation and is named as canal ways. By utilizing the enormous availability of sea water in coastal cities, a more reliable and economical more of transportation can be introduced. Concept behind the canal ways consist of providing canal carrying flowing seawaters from oceans and making a network of water highways on which the so designed floating carts can be drive. For making it more controllable provision of rails alongside the canal is considered. The buoyancy provided by the canal water will provide an uplift thrust and slope in the canal will provide a forward thrust. Resultant of these two forces facilitated by water to the cart will reduce the normal force between the rails and the cart and hence indirectly reducing the frictional forces involved. The cart is designed as a non-mechanically drive, the cost of operation is purely dependent on the head of water flowing in the canal. A steady flow in the canal will be provided by Tidal Dams near the shore that will be capable in driving the whole system without supply of any mechanical or electrical energy. The further detailing on design criterion as a practical point of view is described in this paper.

Keywords: Canal Ways, Tidal Dams, Ocean Power, Self-cleaning velocity, Rectangular Canal Section, transportation, Reinforcement, Structural Design.

1. Introduction

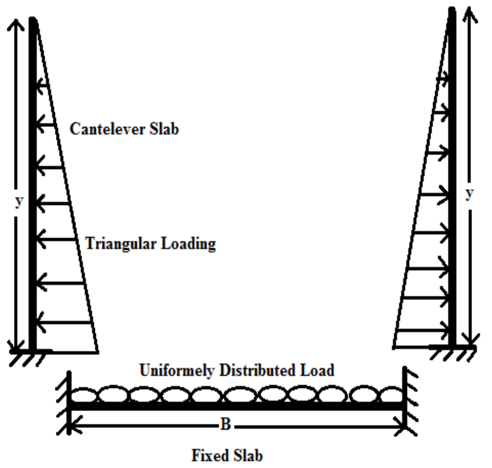
As reference to the previous published paper on canal ways for coastal cities as a mode of transportation. The description of the stress analysis and reinforcement needed is shown in brief. This part comprises the detailing of the concept as seen from a practical point of view and a view of the construction.



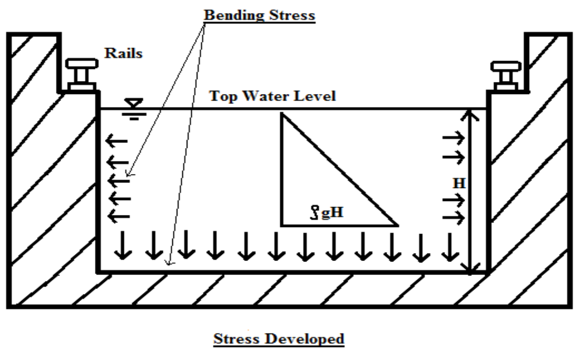
Above figure shows the components of the canal needed for the canal ways construction. The major components are the side walls fixed from one end, the rails and the small projected vertical walls to take compressive stresses and bending stresses provided from the water. Other components comprises of the foundation as a base slab. Foundation and base slab are same, but needs to support bending stresses and transfer load to the soil beneath.

2. Nature of Stress in Components

As shown in figure the side walls are acting as a cantilever slabs and the bottom slab is bending due to compressive loads provided by the water and the weight of the rail along with the live load of transportation cart/wagon. The forces acting on the side walls are trying to bend the wall outside crating a tension zone inside the canal. So as to take these tensile loads the reinforcement needed inside face of the side walls. The projected portion supporting the rails needs to take down the high compressive loads so they will act as column to transfer loads to the foundation. The forces acting on canal will be water pressure at the bottom slab, at the side walls and the excess pressure due to the buoyancy provided to the cart.



Reinforcement needs to be designed for bending stress at the bottom slab and cantilevered slab of the side walls. The side walls is designed for high compression loads provided by the rails. The compressive stresses are transferred to the foundation which is extended from the bottom slab.



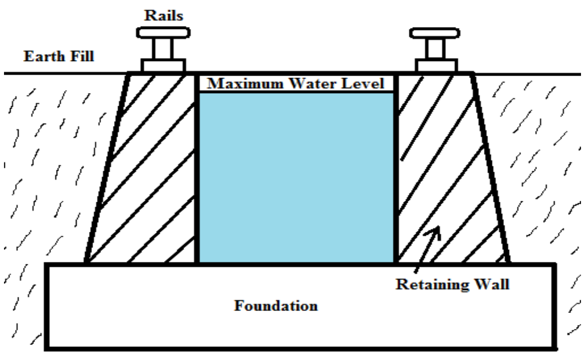
3. Design Assumptions

As per IS Code-456:2000 the minimum grade of concrete used for coastal construction is adopted as M30. Reinforcement bars used is Fe415 steel.

Bearing Capacity of Beach Soil, Clay & Gravel generally found in coastal cities varies from 100kN/m2 to 300kN/m2.

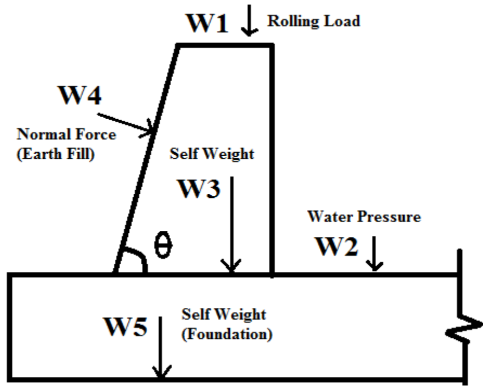
4. Design Modifications

The analysis of stress shows us the portions of canal section under stresses and the exact nature of them. While continuing redesigning in this paper the canal design is modified to a new but more stable structure with similar rectangular section.



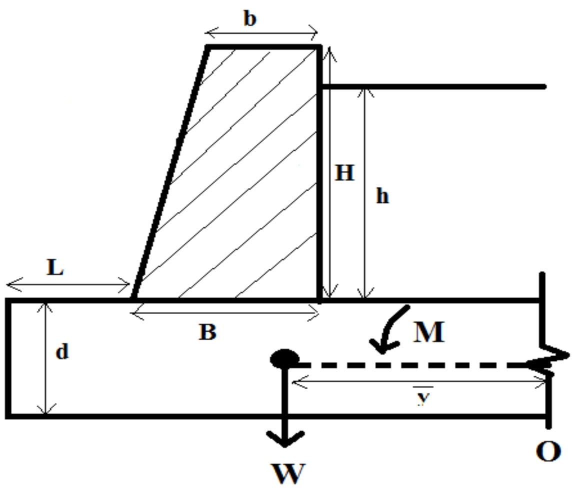
The canal is constructed below the G.L with provision of earth fill and retaining walls at both sides. The new reinforcement needs to be designed to sustain both canals full as well as canal empty conditions. The provision of earth fill provide inward balancing force toward the outward water pressure. Retaining walls are connected directly with the foundation.

5. Loads and Moments



W1- Rolling live load of the cart and dead load of rails.
W2- Water pressure and the reaction buoyancy load at the bottom slab or the top of foundation.
W3- Self weight of the retaining wall.
W4- The normal force provided by the earth filling, with horizontal and vertical components. The horizontal component tend to reduce the outward water pressure on the retaining wall.
W5- Self weight of the foundation.

5.1 Dimension Representation



6. Model Calculation and Formulation

- **6.1 Vertical Load**

$$W1+W2+W3+W4+W5=W$$

$$W1+\delta h+\frac{H(b+B)\delta}{2}+\frac{(B-b)H\delta_s}{2}+dD\delta=W$$

- **6.2 Horizontal Load**

$$H.F=\frac{\rho g h}{2}-W4(\sin^2\theta)$$

- **6.3 Moment about Point O**

$$\bar{y}=\frac{M_W}{W}$$

Mw = [(w1y1 + w2y2 + w3y3 + w4y4 + w5y5 + w6y6) – (Sbc*D/2)]

Sbc- Bearing capacity of soil

Mu (limit) = 0.138*fck*b*d^2

Further Specification regarding reinforcement is to be published in the later part of "Canal Ways for coastal Cities".

7. Acknowledgment
We wish to thank our mentors and college for supporting us in completing our work introducing the sixth way of transportation as Canal Ways. We also wish to thank our parents for providing us with assets that helped us completing research regarding this concept.

8. References

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