INFLATABLE STOPPER CAN FIND MANY APPLICATIONS

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In the process of construction and testing of tunnels, mine shafts, and to stop infiltrated water flowing inside tunnels, usually, the practice is to install stoppers out of concrete, the width of which can be a few metres.

2. Concrete stoppers can be used only once and their construction even with quick hardening cement requires time as a result of shuttering, transportation of materials to site, equipment for concreting etc.

3. At present application of inflatable structures in the field of civil engineering is gradually increasing. In Canada the inflatable stoppers is being used to block the flow in a nine-foot diameter sewer to carry out repairs.

4. Inflatable stopper (pressurized with water or air) can easily be adopted to act as a coffer dam in hydropower tunnels during construction and for testing the tunnel lining. Also, the stopper can be utilized to test penstocks and other pipes.

The stopper can be used in penstocks for emergency and maintenance purposes in this manner.

The deflated stopper may be taken to the penstock through the Surge Chamber.

The stopper can be taken from the spiral case side depending on the repairs carried out.

Under operation conditions the stopper will not be left inside the penstock.

5. The inflatable stopper out of synthetic material consists of a cylindrical part, which when inflated will block the tunnel (pipe) along the periphery. Principal diagram of the stopper for circular tunnel is given in Fig. 1. Cylindrical part A of Length L and semi-circular ends B and C of radius R. Diameter of the cylindrical part must be such that after pressurizing the stopper with water or air it should be tightly in contact with the tunnel lining, the friction between the stopper and the tunnel should keep the stopper in equilibrium against the water pressure from the filled tunnel. Under the given loads the semi-circular sections are under tension. Pressure inside the stopper P_s can be more or equal to the water pressure P_t inside the tunnel. Semi-circular end B is subjected to pressure $\Delta P_1 = P_s - P_o$, where P_o is atmospheric pressure. Semicircular end C is under pressure $\Delta P_2 = P_s - P_t\ (P_s \geq P_t)$.

Tension T per unit length of the synthetic material in the semi-circular section can be expressed $T = \Delta P.R$, where ΔP is the difference of pressure at any point, R the Radius of the semi-circular section.

When the diameter of the tunnel is large and the head of water acting on the stopper is great, the strength of synthetic material becomes insufficient to suffice for pressure difference ΔP_1. In this case the stopper can have a few compartments to reduce the difference of pressure by stops. See Fig. 2.

6. Due to the pressure difference between the parts of the tunnel with and without water, there is the possibility of infiltration through the concrete lining of tunne and along the contact of stopper and lining. The Infiltration Chart has great significance in calculating the minimum length L of the stopper. The drop in the infiltration chart has been assumed to be linear, though the experiment demonstrated it to be otherwise. (This assumption increases the Coefficient of stability). Minimum length L of stopper is calculated from the equilibrium condition; the frictional force should be greater than the water pressure in the tunnel.

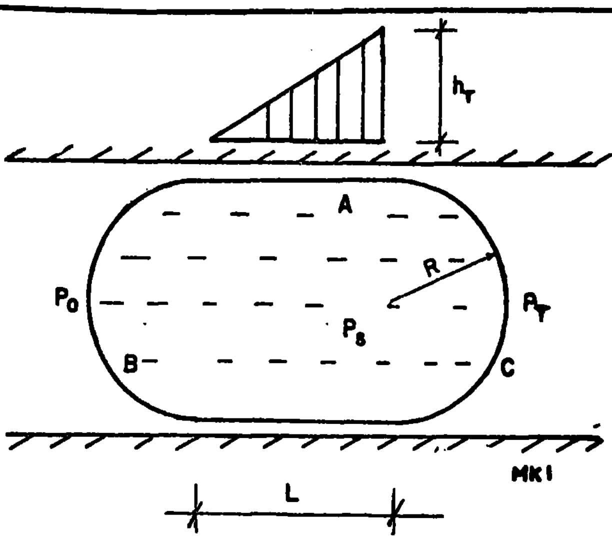

Fig. 1

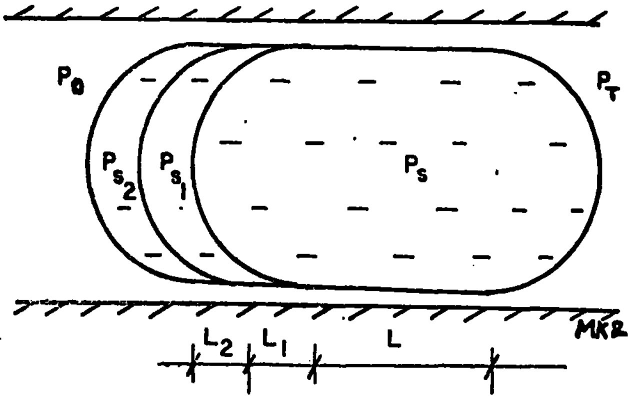

Fig. 2

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