A suspension bridge for rural economic development

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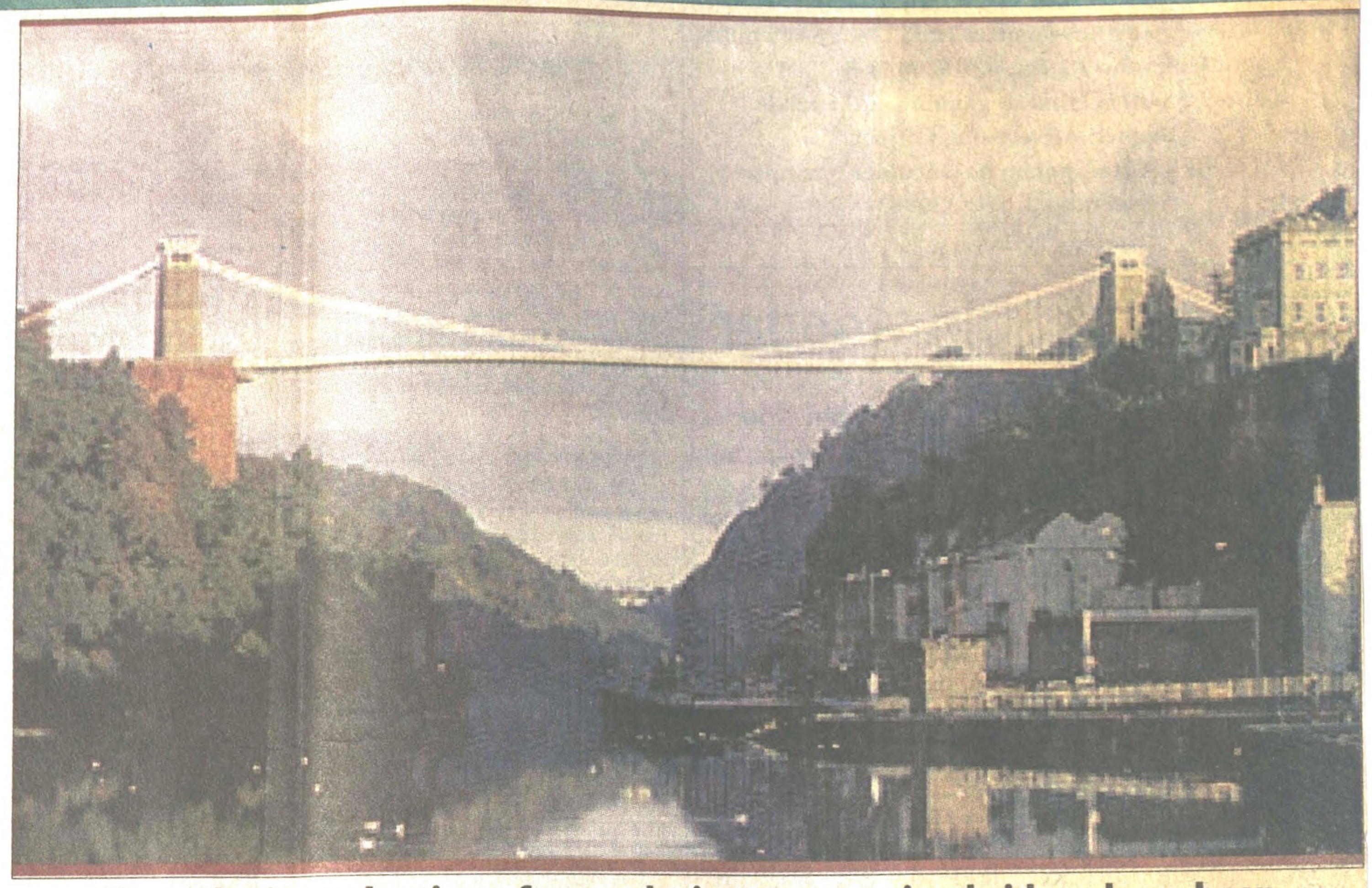

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Villagers in some rural areas of the hill country face an unfortunate situation. They can see the other bank of the river but because of the deep valley they cannot cross it to reach the other side.

In such areas, construction of a bridge would be an expensive exercise. Besides, when the relatively small population that would be served is considered, a huge expense could not be justified. Therefore, the solution adopted by the authorities to this problem is the pedestrian suspension bridge.

Although this provides some solace to the poor villagers, it is by no means an adequate solution. It is of little use to the rural economic development as crops and other goods could not be transported along this bridge. Therefore, there is an urgent need to upgrade these bridges to motorable level.

Recently, one such solution was unearthed at the Annual Sessions 2001, The Institution of Engineers Sri Lanka. Developed by Eng. D. K. Rohitha Swarna (Road Development Authority) and Eng. (Dr) M. T. R. Jayasinghe (Moratuwa University), this solution is an upgraded version of the pedestrian suspension bridge to a light vehicular suspension bridge. Therefore, when difficult foundation conditions are encountered as in deep valleys, this can attract attention as an economical solution.

The paper titled Development of Suspension Bridges for Light Vehicular Traffic presents the details of the proposed suspension bridge. The following is only an outline of the major aspects concerned.

Since the introduction of wrought iron, suspension bridges have been successfully used in many parts of the world - initially for pedestrians, then for horse-driven carriages and finally as a rail and road bridge. In Sri Lanka the suspension bridge is mainly used, as mentioned earlier, for pedestrian traffic across a deep valley - i.e. when any other solution is likely to be more expensive due to the difficulty in the construction of bridge piers.

In the suspension bridge, the bridge deck is carried by vertical hangers, which in turn are hung from two cables running parallel in plan. Each cable is supported by two towers, and the cable ends are anchored to the ground.

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The suspension bridge is a flexible structure. In fact the main reason why the pedestrian one cannot be used by vehicles is the high flexibility of the deck. The single-lane, 42-metre span bridge presented as the case study is expected to allow light vehicles such as tractors, vans, three-wheelers etc. Therefore, the local deformation of the deck due to the weight of the vehicle should be controlled to an acceptable level. In the proposed bridge, this is achieved by introducing a modular system. This facilitates the erection of the bridge as well.

The proposed bridge can be used by a vehicle up to 6.4 tons. Therefore, by allowing 25% for impact and vibrations caused by the vehicles, it would be safe to suggest that vehicles up to 5 tons can safely use the bridge when they are one after the other. This single-file traffic flow is ensured by providing the road width for a single lane only.

Due to inherent flexibility of the structure, a suspension bridge is susceptible to damage due to oscillation under lateral wind forces - especially if the span is long. To counter this problem, the rigidity of the structure of the proposed solution is enhanced by providing a torsionally stiff space struss below the deck and open hand rails as opposed to solid ones.

The tensile force in the main cables of a suspension bridge is resisted by the anchorages at the ends of the two cables. If sound rock is available at a reasonably shallow depth, main cables could be directly anchored to it. Or they could be anchored to mass concrete blocks well-embedded to ground rock. If, however, sound rock or any hard strata is not available at a reasonable depth, massive concrete anchor blocks would be needed. This would significantly contribute to the construction cost of the bridge. As an economical alternative in such situations, a cellular type gravity structure is proposed in this solution. The cavity would be filled with rubble.

The behavior of the proposed bridge was modelled using two different computer software - Microfeap P1 (two dimensionally) and SuperSTRESS (three dimensionally). Both cases yielded similar results.

A cost comparison was carried out for two alternatives in a scenario where the foundation conditions would be difficult. The proposed suspension bridge and a three-span precast concrete bridge with a deep foundation were compared for this purpose. The suspension bridge costs only about 19 million rupees while the precast concrete bridge costs 22 million rupees.

There are other benefits of the proposed suspension bridge. It could be constructed, if necessary, from both ends of the river in modular fashion, speeding up the construction. Besides it could be constructed with locally available materials and expertise so that the country would not lose foreign exchange in the process.

The proposed suspension bridge seems to be a solution to effectively bridge the gap between the rural and urban economy.