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DESIGN AND ANALYSIS OF STRESS RIBBON BRIDGE

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ABSTRACT
A stressed ribbon bridge (also known as stress-ribbon bridge or catenary bridge) is a tension structure similar in many ways to a simple suspension bridge. The suspension cables are embedded in the deck which follows a catenary arc between supports. Unlike the simple span the ribbon is stressed in compression, which adds to the stiffness of the structure whereas a simple suspension spans tend to sway and bounce. The supports in turn support upward thrusting arcs that allow the grade to be changed between spans where multiple spans are used. Such bridges are typically made from concrete reinforced by steel tensioning cables. Where such bridges carry vehicle traffic a certain degree stiffness is required to prevent excessive flexure of the structure.

KEYWORDS: Catenary bridge, Stiffness

INTRODUCTION
Stress-ribbon bridge is the term that has been coined to describe structures formed by directly walked prestressed concrete deck with the shape of a catenary. The bearing structure consists of slightly sagging tensioned cables, bedded in a concrete slab that is very thin compared with the span. This slab serves as a deck, but apart from the distributing the load locally and preserving the continuity, it has no other function. It is a kind of suspension structure where the cables are tensioned so tightly that the traffic can be placed directly on the concrete slab embedding the cables. Compared with other structural types the structure is extremely simple. On the other hand, the force in the cables is very large making the anchoring of the cable expensive.

OBJECTIVE
1) To understand the structural behaviour of the different types of stress ribbon bridges constructed around the world.
2) To identify the parameters essential for the preliminary calculations, permissible limits and sizing of the deck segments.
3) To develop a simplified model for a 45 meter long traditional stress ribbon bridge in ANSYSand analyze the structure by loading it as per IRC loading conditions.
4) Identifying the critical load combinations for a stress ribbon and designing accordingly.
5) To understand the dynamic behaviour of the stress ribbon bridge and its mode shapes.

Classification of Stress Ribbon Bridge
There are 3 types of stress ribbon bridges, namely traditional stress ribbon bridge, stress ribbon bridge supported on an arch and stress ribbon bridge suspended on an arch. All the three types are explained below.

Traditional Stress Ribbon Bridge
The traditional stress ribbon bridge is the one in which the deck segments, either precast or composite sections are directly laid on the bearing cable as explained above. One characteristic of this structure is that it has very slender concrete decks and the stiffness and stability are given by the whole structural system using predominantly the geometric stiffness of the deck. One primary disadvantage of the traditional stress ribbon type bridges is the need to resist very large horizontal forces at the abutments.

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Fig 1 Stress Ribbon Bridge

Stress Ribbon Bridges supported on Arches

The arch serves as a saddle from which the stress-ribbon can rise during post-tensioning and during temperature drop, and where the centre "band" can rest during a temperature rise. The the general structural arrangement of a stress ribbon bridge supported on arches. In the initial stage, the stress-ribbon behaves as a two-span cable supported by the saddle that is fixed to the end abutments The arch is loaded by its self-weight, the weight of the saddle segments and the radial forces caused by the bearing tendons. After post-tensioning the stress-ribbon with the prestressing tendons, the stress-ribbon and arch behave as one structure. The shape and initial stresses in the stress-ribbon and in the arch can be chosen such a way that the horizontal forces in the stress-ribbon H_{SR} and in the arch H_A are the same. It is then possible to connect the stress-ribbon and arch footings with inclined compression struts that balance the horizontal forces. The moment created by horizontal forces H_{SR}*h is then resisted by the V*L_P. In this way a self-anchored system with only vertical reactions is created.

An example: It is pedestrian bridge across the Svratka river in Brno, Czech Republic. It has an arch span of 42.9 metres and an arch rise of 2.65 meters. The span of the bridge is 43.5 metres long assembled from precast segments 1.5 meters each. The bridge was built in 2007.

Fig2 Stress Ribbon Bridge Supported On Arches

Stress Ribbon Bridges suspended on Arches

It is also possible for the stress-ribbon to be suspended from the arch. It is then possible to develop several self-anchored systems. An arch fixed at the anchor blocks of the slender prestressed concrete deck. The arch is loaded not only by its self-weight and that of the stress-ribbon, but also with the radial forces of the prestressing tendons. A structure that has a similar static behaviour as the structure presented a similar structure in which the slender prestressed concrete band has increased bending stiffness in the portion of the structure not suspended from the arch.

An example for stress ribbon bridges supported on arches is given inMcLoughlin Boulevard Pedestrian Bridge, Portland, Oregon, USA was constructed in 2006.

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Fig.3 Stress Ribbon Bridge Suspended On Arches

CONCLUSION

Stress-ribbon bridge is the term that has been created to describe on which pedestrians can directly walk and is in the shape of an inverted arch. The structure consists of tensioned cables which have slight sag in them, embedded in a concrete deck which is very slender when compared with the span. This deck serves the purpose of distributing the loads and to maintain the continuous nature of the deck,.It is a type of a suspended structure where the cables are tensioned so tightly that the pedestrian load can be placed directly on the concrete deck in which the cables are embedded. It's a very simple structure when compared to other complex structures like suspension bridges. The only drawback of these bridges is the very fact that the tensioning force is so high in the cables that one has to anchor its abutments which makes the bridge expensive.

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