LIGHTWEIGHT STRUCTURES AND INNOVATIVE MATERIALS FOR FOOTBRIDGES

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Summary

Lightweight structures are nowadays desired in innovative and simple structures as footbridges. An extended investigations on new materials and especially high strength materials has been carried out in order to give to designers and engineers a quick and easy reference for the specifications of material properties in their project. Some of the study is also dedicated to innovative types and structures, in the framework of sustainable constructions.

Keywords: footbridge; structural concepts; planning; new materials.

1. Materials and Innovations

1.1 Steel

Contemporary steels used in today's footbridges are mainly related to high performance steels with yield strengths of 355 and 460 MPa widely used, while also superior yield strengths in excess of 690 MPa could be supplied. Steels for modern bridges include some relevant topics as: weathering steel; high performance steel; longitudinally profiled plate; high strength steel; constant yield point steel; high toughness steel [1]. Weathering steels are high strength low alloy steels, which under normal atmospheric conditions give an enhanced resistance to rusting compared with that of ordinary carbon manganese steels. Weathering steel bridges do not require painting. Periodic inspection and cleaning should be the only maintenance required to ensure the bridge continues to perform satisfactorily. Hence, weathering steel bridges are ideal where access is difficult or dangerous, and where future disruption needs to be minimised. Cost savings from the elimination of the protective paint system outweigh the additional material costs. Typically, the initial costs of weathering steel bridges are approximately 5% lower than conventional painted steel alternatives. In addition, maintenance requirements of weathering steel bridges greatly reduces both the direct costs of the maintenance operations, and the indirect costs of traffic delays or rail possessions. Among high performance steel, type 70W is a new high strength weathering steel that has been developed in the USA over the last decade. The key features of this steel are high strength, high toughness, good weld-ability, and enhanced durability. Even if also high performance steel 70W has proved to be very cost effective for highway bridges, and is becoming widely specified for new bridges, minor grades are required for footbridge solutions. The demand to reduce self-weight was the starting point for the development of longitudinally profiled plates (LP-plates). By a special control of the rolling gaps during the rolling process, a longitudinal profile with a continuously varying thickness along the length of the plate can be given to a heavy plate. Various types of longitudinal profile plates with different geometries can be produced. Concerning the so called longitudinally profiled plate, such plates allow an optimized adaptation of the plate thickness to the actual stress in the structure. In addition, the use of longitudinal profile plates can speed fabrication and reduce costs as complicated welds can often be avoided. Avoiding such welds also enhances the fatigue performance of the bridge structure. Today, longitudinal profile plates are currently used in bridge building all over[1]. About the high strength steel type, developments in rolling processes, combined with new chemistries, have allowed steelmakers around the world to produce grades suitable for bridge construction with higher strengths of 460Mpa, 690Mpa and above. Moreover, the use of such steels on appropriate bridges offers many benefits. Plate thicknesses can be reduced leading to savings in material requirements and fabrication processing (for example, cutting, welding and drilling). The reduction in self-weight benefits transportation, handling and erection, and even facilitates longer spans. In addition, the resulting slimmer structures are generally more elegant and aesthetically pleasing. Another recent improvement lies on a steel has been developed in Japan that offers a