Innovative footbridges used as urban furniture for our cities for the future

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ABSTRACT: This publication shows several singular urban footbridges that I’ve designed as structural elements integrated as part of an urban street furniture, composed by light, slender and elegant designs. They are cable-stayed constructions made of concrete and steel, with metallic decks or concrete slabs. The pavement is in wood or concrete. Attractive and distinct, they are conceived to provide continuity to pedestrian routes, or joining areas with heavy traffic, also having the function to define spaces, thus creating distinct landmarks.

1 A METALLIC STAYED FOOTBRIDGE IN ARTEIXO. CORUÑA. SPAIN

Photos 1 and 2, shows an eccentric stayed footbridge located in the borough of Arteixo, province of La Coruña, in Spain.

The footbridge has a steel deck with a smooth “S” shaped design in plant, 160 meters long, without expansion joints. The access ramps are composed by two spans of 17.50 m each side and the direct span is composed by two continuous spans of 30 m in length.

The extreme access ramps are supported in eccentric tubular pillars, 457.2 mm diameter and 20 mm thick. The central span is suspended from a set of 12 eccentric ties, with a double harp form, extended from one edge of the deck up to one inclined metallic tubular slender pylon, 609.6 mm in diameter, which is situated on the road axis.

The deck is 3 m wide, and maintains the same cross section throughout all the footbridge, it is composed of a eccentric steel tube, 508 mm in diameter, with metallic cantilever beams, of variable depths, joined at the other edge to a small metallic tube, 127 mm in diameter. Metallic diagonals were arranged to strengthened horizontal areas with greater horizontal moments.

The wood pavement, 200 cm wide, which is narrower than the board, leaves individual empty spaces at both sides, it is of ipe wood, that is very compact and has a high density.

The metal railing adds the final touch to the concept, extremely light in its design and executed with a different material, stainless steel, complementing the slenderness of the board that can only be improved by structures with a stress ribbon typology.

Illumination has been projected to focus on the structural vertical elements, in order to project the height of the footbridge. In addition, the illumination by way of LEDs has been added and fitted to the board, making the zigzagging run visible at night.

Photo 1. Photo 2.
2 A ECCENTRIC STAYED FOOTBRIDGE
“THE ROSE” IN CORUÑA SPAIN

This footbridge, see photos 3, and 4, with an attractive design, crosses the Avenue of San Cristobal in la Coruña, Spain.

The curved board is completely suspended from the inner edge, because the footbridge cannot rest on the area where the petroleum piping installation is situated. The difference in the levels on the other side makes the support aesthetical unattractive.

The footbridge's deck, 156 meters long, with an oval plant is suspended from a set of 44 eccentric ties extended from the inner edge of the deck up to two inclined metallic pylons, 36 meters high, in spindle shaped, and located in the borders of the Avenue, totally separated from the footbridge.

The balance of the pylons demanded the disposition of two tubular counter stays post-tensioned on each pylon anchored into the abutments and in the central element.

3 THE FOOTBRIDGE “THE SAILBOAT” IN CORUÑA SPAIN

The footbridge, see photos 5 and 6 with a pleasing design, crosses the Avenue of San Cristobal, in Spain, La Coruña, and is situated in the only available public plot which is located in the closest area to the city, presently occupied by a petroleum pipe installation. The lot on the other side was limited by the existence of other gas reservoirs. The significant cantilevers appear because the structure cannot rest on these plots and the footbridge alignment, which is not orthogonal to the avenue, depended on these plots location and on a future avenue alignment.

The footbridge has a clear span of 39 meters in a straight line with a parabolic elevation, to which two access metallic ramps in cantilever, 30 meters span, are added. The design of the ramps, which is the most significant element, is zigzag-shaped, with a 10 per cent gradient. The ramps are linked to one another by vertical tubular transoms, and constitute a
Vierendel beam with a linearly variable depth, having a maximum value of 5.50 m.

The board cross section, of metallic structure, was designed with a plane wing profile, like the one used in the Rose footbridge.

The footbridge was designed with a very stiff V-shaped centre pylon in reinforced concrete. There are as well two pillars also made of reinforced concrete at the beginning of the ramps. The direct span of the footbridge is not symmetric, it is suspended eccentrically from the centre pylon by 6 ties, 3 on each side. A horizontal tie was designed to link the two pylon braces on the top.

The ramps compensate the torsions with the bending action on the vertical tubular transoms. The cantilever ramps, of 30 meters of span, generate a significant traction over the board and the compression forces in the foundation. The imbalance due to the overloading action on one side of the central pylon is absorbed by the bending acting over the pylon.

4 THE FOOTBRIDGE “THE SWING” IN CORUÑA, SPAIN

The footbridge, see photos 7 and 8, with an elegant design, crosses the Avenue of Alfonso Molina, the main access route to the city, with a clear span of 57 m in a straight line, to which two helix 12 m in diameter are added. The overall length is 113.55 m. The clear span is parabolic in elevation with a rise to span ratio of 1 to 30.

The deck is of reinforced concrete, with a width of 4,00 m and a thickness of 40 cm. The depth of the deck results in a very light structure whose gracefulness can be easily appreciated.

The access ramps are each supported on 10 steel tubes, 203 mm in diameter, which spring from a single point. The direct span of the footbridge is suspended from two sets of ties, arranged along two hyperbolic paraboloids of outstanding beauty. These paraboloids give the appearance of an enveloping parabolic form, whose aspect varies considerably, depending on the viewpoint.

The ties extend from the borders of the deck up to two inclined pylons located in the centre of the Avenue, totally separate from the footbridge. These pylons, again, work almost completely in compression, since the forces transmitted by the ties balance each other against the two sets of anchor ties that are also located along the centre line of the Avenue, forming a harp pattern, and are anchored to a wall. The steel pylons, are 29.50 m in length, they measure 90 cm in diameter at the base and 60 cm at the head, that is topped with a sloping plate.

5 A SMALL METALLIC FOOTBRIDGE WITH AN ECCENTRIC AND LEANED STRUCTURAL ARC IN ORENSE, SPAIN

Photos 9 and 10, shows a steel footbridge, situated in Orense. It has a straight line deck, 26 meters long, and a single span of 20 meters. The deck is supported...
by a leaned steel eccentric arc, 229 mm in diameter suspended from the arc in the Orense side that is also supported on the other boarder, due to the headway limitations.

The deck is 2.80 meters wide. The cross section is composed of a steel eccentric tube, 305 mm in diameter, with steel cantilever beams, of variable depths, joined at the other edge to a small steel tube.

The pedestrian zone is narrower than the board, leaving individual empty spaces at both sides, and is constituted by a structural concrete slab 7 centimeters thick and 2 meters wide, linked to the decks top sheet with steel profiles.

6 FOUR METALLIC FOOTBRIDGES WITH SLABS DECK IN COMPOSITE SECTIONS IN CONCRETE AND STEEL

The deck in these footbridges was designed as a composite section of steel and concrete, extremely lightweight and slender, formed by a metallic inferior sheet reinforced a with metallic profiles, linked to a higher thinner slab.

6.1 Footbridge “A Xuntanza” in Oleiros. Coruña. Spain

The footbridge, see photos 11 and 12, crosses the road with a clear span of 26 m forming a straight line, to which are added two helix 12 m in diameter. The deck is 2,30 m wide and 18 cm deep, resulting in a very light structure.

The border edges in the direct span were suspended with metallic bars from a polygonal tension arc, composed of a tube, 106 mm in diameter, with a clear span of 27,5 m, and a rise to span ratio of 1 to 6. The access ramps are supported by several pairs of leaned pillars, 132 mm in diameter, linked together at the base.

Four pillars designed on the borders of the road sustain the arcs. The balance of the pillars demanded the disposition of a counter tie in each pillar.
6.2  Footbridge “Whistle” in Oleiros. La Coruña, Spain

This is a very simple structure, where the employed materials work in a rational way, due to the lightness of its design it was named “whistle”. See photo 13.

The deck, 18.30 m long, 2.20 m wide and 160 mm deep, is supported in a compression arch through seven pairs of V shaped pillars, composed by tubes 82.5 mm in diameter.

The antifunicular compression arc formed by a tube 15.25 m in length and 160 mm in diameter, is embedded in the borders against the rocky embankments of the road.

6.3  Footbridge in Vigo. Spain

The footbridge, see photo 14, is located on the access road to Vigo’s university, it has a deck with a U shaped design in plan, composed by two access ramps, 26.5 m long, and a direct span of 27 m long.

The inner border of the deck is stayed by means of a set of ties in three orthogonal planes. The deck is 1.7 m wide, and has a cross section composed of an eccentric metallic box, with metallic cantilever beams, of variable depths, joined to other edge by a small metallic profile. The pedestrian walkway over this deck is 1.5 m wide.

Two pillars were designed on the borders of the road from which the footbridge was stayed. The balance of the pillars demanded the disposition of two counter ties in each pillar.

6.4  Footbridge in Iñas. Oleiros. La Coruña. Spain

Photo 15 shows the direct span of a footbridge from a previous project designed many years ago but built recently. The deck is eccentrically suspended by a leaned metallic arc with metallic bars. The deck has a torsion border tube with cantilevers of variable depths as was explained before.

7  FUTURE FOOTBRIDGE “AS, IN FERROL, CORUÑA, SPAIN

Photo 16 shows the model of a footbridge whose project has been recently approved by the Port Authority of Ferrol, this construction will be situated at the entrance-way to the port of the city.

The footbridge will have a steel deck with a smooth “S” shaped design in plant, 190 meters long, to be located in the available plot. The access ramps are composed by two spans in the Ferrol side that are 20 m in length and another span of equal length on the opposite shore. The central main span is 60 m long and is eccentrically suspended from a set of ties, with a double harp form geometry. The direct span is compensated with two eccentric stayed spans that are 18 m in length. The ties are extended from one edge of the deck up to the two inclined metallic tubular slender pylons, 864 mm in diameter and 37.5 m in length.
The extreme access ramps are supported by eccentric tubular pillars, 609.6 mm in diameter. The deck is 3.768 m wide, and maintains the same cross section throughout the footbridge. It is composed by an eccentric steel tube, 622 mm in diameter, with metallic cantilever beams, of variable depth, joined at the other edge to a small metallic tube, 146 mm in diameter. The metallic tubular diagonals 60.3 mm in diameter, were arranged along the deck.

The wood pavement, 240 cm wide, that is narrower than the board, leaves individual empty spaces at both sides. It is of ipe wood, that is very compact and dense. Illumination has been projected to focus on the structural vertical elements, in order to emphasize the height of the footbridge. The illumination by way of LEDs has been added and inlayed to the board, making the zigzagging run visible at night. In addition the illumination of the end ramps highlights the walkway and invites the pedestrians to cross.

REFERENCES