



150 km of U Shape Prestressed Concrete Decks for LRT Viaducts

Daniel DUTOIT
Consultant
SYSTRA
Paris, France

ddutoit@systra.com

Yves GAUTHIER
Director of the Civil
Engineering
Department
SYSTRA
Paris, France

ygauthier@systra.com

Serge MONTENS
Chief of the Bridge
Division
SYSTRA
Paris, France

smontens@systra.com

**Jean-Charles
VOLLERY**
Director for Civil
Engineering in
Asia
SYSTRA
Delhi, India

jcvolley@systra.com

Summary

SYSTRA has developed a system of U shape prestressed concrete decks for LRT viaducts. The many advantages of this system are presented, along with the design concept: system integration and deck design, architectural design, deck computation. Examples of applications throughout the world are described.

Keywords: LRT, U shape, viaduct, prefabrication, prestressed concrete

1. Introduction

With the huge development of large cities worldwide, the need for efficient grade separated LRT systems is increasing significantly. LRT owners often decide to put transit systems on long viaducts. However, environmental considerations require that great attention is paid to landscaping, architectural appearance, and noise impact for these infrastructures, which are built amidst an urban environment.

The U shape prestressed concrete deck described below, developed by SYSTRA, is an economically efficient answer to requirement of urban development.

This deck has many advantages compared to conventional box-girder type deck.

2. Advantages of U-shape prestressed concrete decks

With a U shape section, the structural depth below the track is equal to the bottom slab thickness. Therefore it is possible to lower the project rail level by 1 m to 1.80 m. This minimized visual impact is probably one of the main advantages of U-shape prestressed concrete decks.

Due to the above mentioned lowering of the longitudinal profile of the line, the level of the stations can also be reduced. This of course reduces their cost, since wind and seismic forces applied to the piers and foundations are reduced. This is also beneficial for the passengers who have to climb from the road level to the platform level.

In the station, the tracks can be supported by the same deck cross section as for the typical viaduct. The typical 'U' passes through the station and its construction can be independent from the station construction. This allows standardisation of the deck section all along the line, stations included.

The U shape structure was first conceived by a system wide multidisciplinary value engineering team of Systra experts. It is a value engineered structure as it integrates economically all components of the system in a very convenient and practical way, considering both installation and maintenance. This feature of the U shape section is covered by a SYSTRA international patent.

The deck concrete section is reduced compared to a typical box-girder section. Furthermore, thanks to the lowering of the line longitudinal profile, the bending moments applied to the piers and foundations are reduced, and therefore the material quantities for the piers and foundations are also reduced, both for the typical viaduct and for the stations. The global reduction of quantities and cost is between 20 and 40 %.

The side beams are used for structural purpose, but they can also serve for three other functions. They are used as noise barriers. They are also capable of retaining the train on the bridge in case of derailment or severe earthquake. Then, the top flange of the side beams can be used as emergency and/or maintenance walkways, because they are located approximately at the level of the train car floor.

3. Applications

The first application of this concept was for Santiago in Chile (metro line N° 5). SYSTRA prepared the basic design in 1992-93 and collaborated in the construction supervision for the 5.6 km of viaduct and 6 elevated stations built with the 'U' concept.

In 1998, SYSTRA prepared the basic design of the Guangzhou line n°2 (China) and supervised the detailed design. For this same project, the client (City of Guangzhou) requested to have the typical structure fully tested under actual conditions, up to ultimate loads and destruction. The tests were very successful and the Local authority approved the concept for use in Guangzhou and also in the rest of China.

In 2001-2002, SYSTRA prepared the basic design of the Neihu Line (extension of Mucha Line) in Taipei (Taiwan). The 11 km long project has been built, with small U sections, for 25 m spans, fully precast.

In 2003-2004, two other projects have been designed by SYSTRA:

- Santiago metro line n° 4: 6.91 km of viaducts and 6 elevated stations, with a wide U section,
- Delhi metro line n° 3: 21.7 km of viaducts and 21 elevated stations, with a wide U section.

In 2004-2006, another large project has been designed by SYSTRA for Dubai LRT system, with a total of 62 km of U shape prestressed concrete viaduct and 34 elevated stations.



Fig. 1. Dubai metro typical span

Some other projects have been or are currently being designed by SYSTRA:

- Uijongbu LRT (Korea), including 11.2 km of viaducts with small U sections
- Shanghai metro line n° 8 (China), including 6.35 km of viaducts with small U sections,
- Mumbai LRT (India), including 11.1 km of viaducts with small U sections,
- Taichung MRT (Taiwan), including 20 km of viaducts with small U sections,
- Delhi Airport Link (India), including 7 km of viaducts with small U sections,
- Lahore metro line (Pakistan), including 14.7 km of viaducts,
- Ho Chi Minh metro line 2 (Viet-Nam), including 7.2 km of viaducts,
- Damas metro green line (Syria), including 6 km of viaducts,
- Mecqua metro (Saudi Arabia), including 16.7 km of viaducts.