

# Shear load connectors in rail viaduct superstructure – ‘All Aboard Florida’

*The structural design team working on the elevated sections of the All Aboard Florida project at Miami Station identified shear load connectors as a suitable solution for load transfer at transverse joint locations within the rail viaduct superstructure. However, they needed to ensure that the system would cope with stringent dynamic load conditions. Hervé Poveda of Ancon and the Meadow Burke engineering team outline the application and the test method used to check the dynamic loading behaviour of the Ancon DSD-style connectors selected for this project.*

**P**roprietary shear load connectors have been used extensively for over a quarter of a century to transfer predominantly static loads across movement joints in concrete structures. These systems replace traditional keyed joints, which can be difficult to construct due to the intricacy of the local reinforcement detail. The problem with keyed joints is further compounded by the limited design life of elastomeric bearing pads.

Shear load connectors are two-part systems consisting of a sleeve that is fixed to the edge formwork of the first phase and a dowel component that is inserted in the sleeve through a compressible joint filler before concrete placement of the second phase. The two-part assembly of the system guarantees dowel alignment and effective movement. Dowel bars are manufactured from Duplex stainless steel for optimum strength and corrosion protection.

## All Aboard Florida

All Aboard Florida is the first phase of the Brightline Express Train Service that will connect passengers from Miami to Fort Lauderdale all the way through West Palm Beach, transporting passengers at speeds between 80 and 125 miles per hour.

The Miami portion of this US\$3 billion (£2.2bn approximately) project began in early 2015 as part of the first phase of construction of the railway system. The project will take several years to complete and station construction at the four destination cities are at various stages. The firm of Skidmore, Owings and Merrill is responsible for the design of the three South Florida stations.

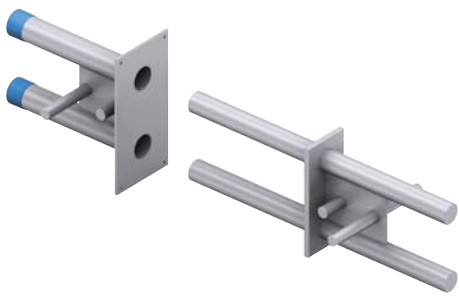


Artist's illustration of All Aboard Florida Miami Station.

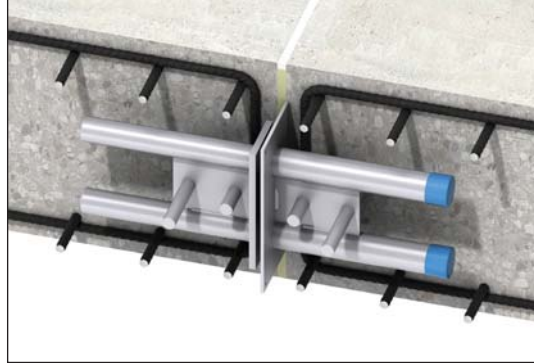
The service between Miami and West Palm Beach launched in 2017, while the route from Miami to Orlando will follow. Suffolk Construction was the general contractor for the Miami portion of the project working alongside Baker Concrete, who was responsible for the concrete base of the railway system.

## The application

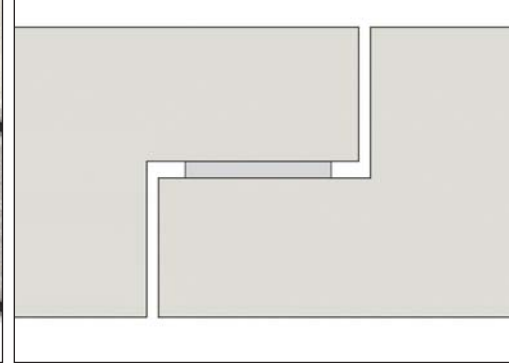
The rail viaduct superstructure at Miami Station consists of a 9-inch (230mm) thick reinforced concrete deck supported on prestressed concrete Florida-I beams. The double-track sections are typically supported on four beams and the single-track sections



Standard Ancon DSD two-part connector.



Typical DSD installation.



Keyed joint.

on three beams. Two types of prestressed beams are used depending on location: shallow Florida I-45 sections and deep Florida I-78 sections.

At transverse movement joints, the reinforced concrete deck section increases to 15-inches (380mm) in order to accommodate the Ancon shear load connectors. The movement joints in the double-track sections contain 14 specially modified DSD150 double dowel connectors, with the single-track sections containing nine of these proprietary connectors.

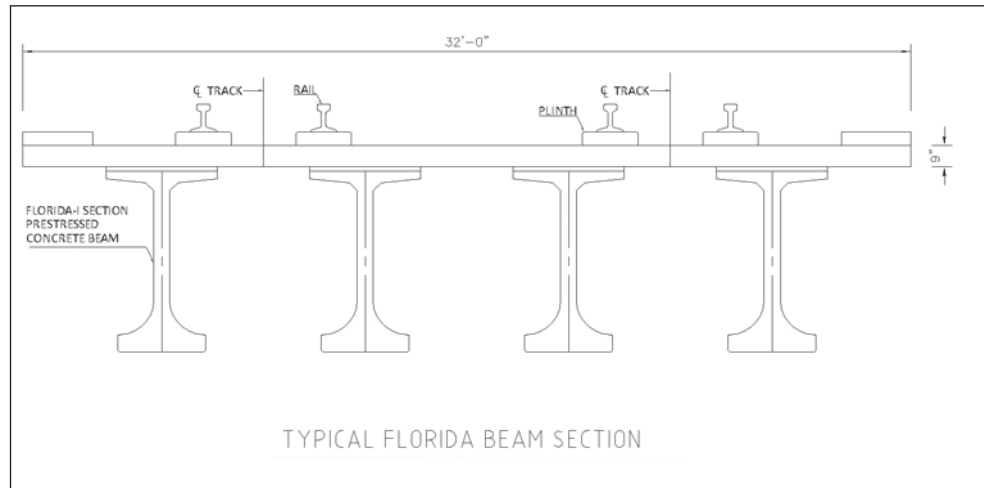
### The challenge

When designing a railway structure, it is mandatory that certain load requirements are met for safety and long-term performance. The shear load transfer requirement for the reinforced concrete deck at Miami station was greater than 330 kips (1334.5kN). Additional fatigue testing was requested by AECOM, structural engineer for the railroad track system, in order to demonstrate that the system would meet the expected loading requirements for the lifetime of the railway superstructure.

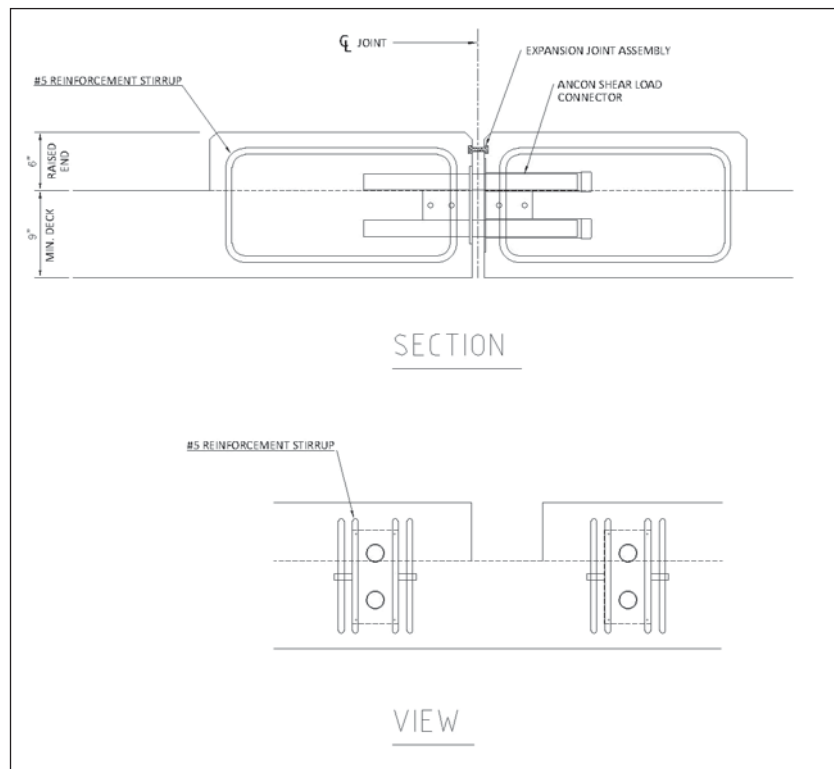
To demonstrate the superior performance of modified DSD150 double shear dowel connectors, laboratory testing was developed by Ancon. This testing subjected the dowel bars to an alternated load range of 25 kips (111.2kN) per device with a minimum load of 3 kips (13.3kN), the maximum applied stress range at the extreme fibre of the dowel bar being 24ksi (165.5MPa). Stress levels were monitored in real time using a series of strain gauges. The tests were conducted over ten million cycles, corresponding to a service life requirement of 75 years. The Ancon system exceeded the performance specification's acceptance criteria.

### The solution

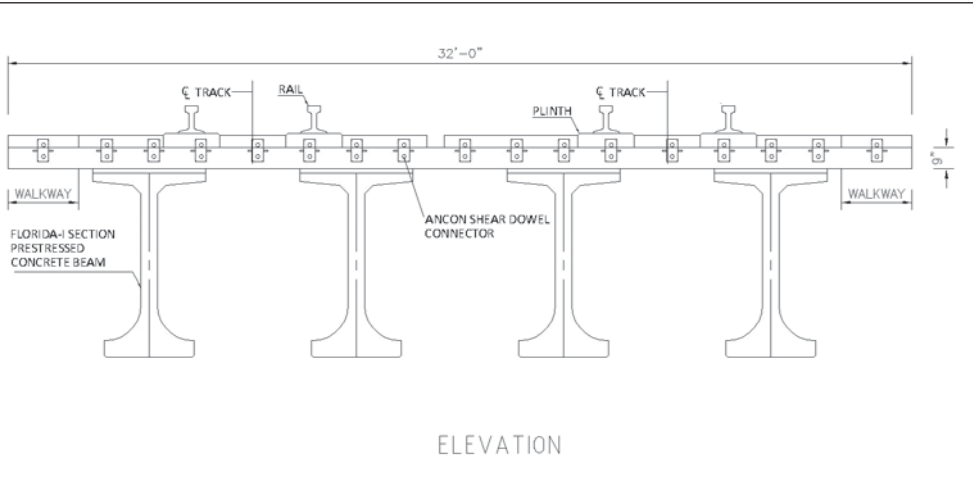
DSD150 double shear dowel connectors were specially modified to ensure optimum performance under cyclic dynamic loads. The welds between web plates and dowel bars were eliminated from the design in order to avoid stress raisers that could potentially cause premature system failure and instead special clamps were incorporated at the



Typical deck section with four Florida I-78 prestressed concrete beams.



Movement joint detail – section.



..... Movement joint detail – elevation.



..... Installation of the specially modified Ancon DSD connectors for high shear load transfer.

extremities of the dowel bars and the tubular sleeve to guarantee parallelism through the system.

The system was supplied to the project by Ancon's sister company in the US, Meadow Burke, also a CRH company.

Professional Engineering sealed designs conforming to ACI 318-11<sup>(1)</sup> were provided to AECOM by Eriksson Technologies to demonstrate that the connectors would meet the expected loading requirements for the lifetime of the railway superstructure. The innovative collaboration between Meadow Burke, Eriksson Technologies and Ancon produced a viable solution for this high-speed rail system. The All Aboard Florida project has a safe, cost-effective solution to withstand

shear loadings at transverse movement joints that will enable the project to continue towards completion. ■

**Reference:**

1. AMERICAN CONCRETE INSTITUTE, ACI 318-11. *Building Code Requirements for Structural Concrete and Commentary*. ACI, Farmington Hills, Michigan, USA, 2011.

**All Aboard Florida Rail Viaduct Superstructure, Miami Station**

Main contractor	Suffolk Construction
Reinforced concrete deck contractor	Baker Concrete
Structural design	Skidmore, Owings and Merrill
Structural engineering – railroad track	AECOM
Shear connector system manufacture	Ancon
Shear connector system supply	Meadow Burke
Shear connector system design	Eriksson Technologies



..... Modified DSD connectors showing clamped dowel bars.



..... Cyclic testing rig.