Concrete bridges for Castletown to Nenagh road scheme

The N7 national primary road connecting Dublin to Limerick is currently being developed by the Irish Government as part of the National Development Plan. This route also forms part of the European E20 Route.

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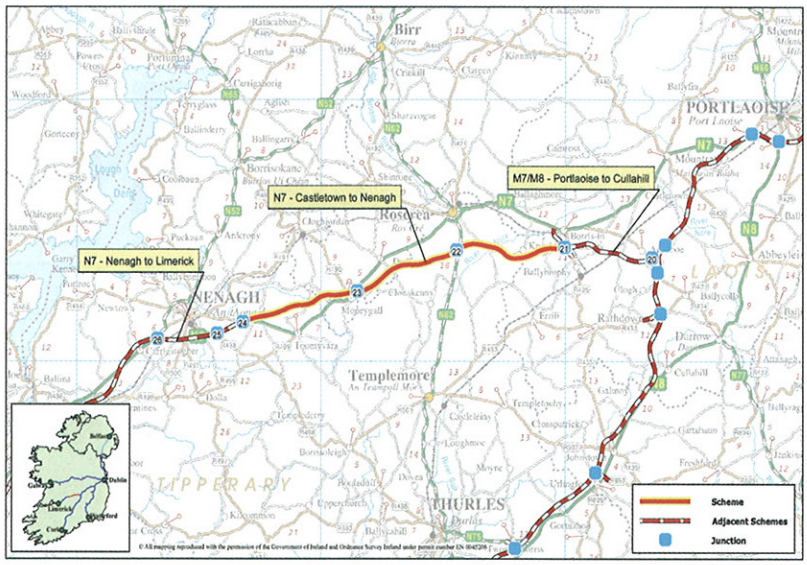
In Ireland, Transport 21 is a capital investment framework under the National Development Plan through which the transport system will be developed, over the period 2006–2015. This framework will address the twin challenges of past investment backlogs and continuing growth in transport demand. One of the Transport 21 aims is to upgrade the status of the four main interurban routes to motorway status.

The realignment of the existing N7 road has been divided into a number of construction contracts. The realignment of the N7 Castletown to Nenagh design-and-build contract was awarded by the National Roads Authority to Bowen Somague, an Irish–Portuguese Contruction Joint Venture (JV). Atkins Ireland is the main designer appointed by the JV. Atkins is responsible for the detail design of all elements of the road scheme, including highways, geotechnical, structures, drainage and environmental engineering.

The road scheme, with a construction cost of circa €160 million, is 36km long comprising a dual two-lane carriageway road cross-section to motorway standard with four grade-separated interchanges. The scheme starts at the most easterly junction of the existing Nenagh bypass and finishes at the Borris-in-Ossory Interchange, which will be constructed as part of the M7/M8 PPP road scheme. Construction work on this section of the road scheme commenced in April 2008 and the target date for completing the route is September 2010. The location of the N7 Castletown to Nenagh road scheme is shown in Figure 1.



(Illustration: Ordnance Survey Ireland.)

Figure 1: Map of realigned N7.

Bridge structures in the scheme

General

There are a total of 45 bridge structures in the scheme, including 13 principal culverts. A breakdown of the structure types is shown in Table 1.

All the bridge structures are concrete structures with span lengths varying from 2.1m to 32m. It is a contract requirement to maintain aesthetic uniformity of structures by creating a family of structures within the scheme. This is achieved by using constant deck cantilever, similar span/depth ratios, similar abutment depth and using the same substructure dimensions, including pier diameter and pier crosshead depth for a family of structures.

Precast concrete elements have been used wherever possible to achieve the contractor's construction programme. When complete, in total, 83,000m^3 of concrete will be incorporated into the structures, of which 61,000m^3 or circa 75% will be precast.

To satisfy the client's requirements for the structures' durability, 50% of the cement in the exposed concrete elements is replaced by GGBS (ground-granulated blast-furnace slag – a by-product of the steel industry). This replacement has resulted in more eco-friendly and high-density concrete with less heat of hydration, which in turn has reduced early thermal cracking in exposed concrete faces.

Underbridges and farm accommodation underpasses

These structures were required early in the project by the contractor, to facilitate earthworks movements within the scheme. To speed up the design, fabrication and approval of underbridges, a constant internal height and width is used for four precast ABM Opti-Cadre box structures up to 60m in length. A photograph of a typical Opti-Cadre type structure is shown in Figure 2.

Due to span limits of precast box structures, three underbridges consisted of precast prestressed concrete beams on bankseats/columns with reinforced earth abutment and wingwalls. Movement of these structures was accommodated by the substructure. Figure 3 gives an example of a typical underbridge structure of this type.

All the farm accommodation underpasses are of 4m

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Table 1 – List of structures in the scheme

Type	No.	Span Arrangement	Type
Underbridges	7	Single-span bridges	Precast prestressed concrete beams or precast box
Farm accommodation underpasses	6	Single-span underpass	Precast box
Overbridges	14	Two-span bridges	Precast prestressed concrete beams
	2	Four-span bridges	Precast prestressed concrete beams
River bridges	3	Single-span bridges	Precast prestressed concrete beams
Principal culverts	13	Single-span culverts	Precast box

Figure 2 top left: Precast ABM Opti-Cadre box being installed for underbridge, S35.

Figure 3 top right: Single-span integral underbridge S11 under construction.

Figure 4 above left: Structure S08 – a typical two-span overbridge.

Figure 5 above right: Ollatrim river bridge S07.

Figure 6 below: A typical principal culvert in the scheme.

span. A precast ABM Opti-Cadre box solution is used for these underpasses.

Overbridges

Two-span integral overbridges in this scheme were designed using precast concrete beams with in-situ deck made integral with the substructure. This eliminated the need for expansion joints and bearings.

To satisfy contract maintenance and inspection requirements, a 1.5m-wide inspection platform was provided in front of each abutment with access from the road above.

Concast Super-U (CSU) beams and U-Beams are used for the overbridges superstructure, as they provide a more economical solution than U-beams. The CSU beams are similar to U-beams but are 1.5m wide at the base (U-beams are 0.97m wide) and are spaced at up to 3m centres. This requires fewer beams per bridge without the need for high concrete transfer strengths. The CSU-beams also have the added advantage of increased torsional capacity and stability during construction.

There are two four-span semi-integral overbridges in the N7 scheme with skew up to 56 degrees. For these overbridges, the superstructure is made integral with the pier, and bearings with inspection galleries are provided at abutment locations.

River bridges

There are three single-span integral river bridges in the scheme. To comply with the Fisheries Board's requirements a setback of 5m is provided from the river to the abutments.

These bridges were not on the critical construction path as the contractor provided a temporary Bailey bridge at each river for initial earthworks movement. Also, a setback of 5m to abutments enabled the building of these bridges during the Fisheries Boards' constrained construction period of October–April. A photograph of a typical river bridge type structure is shown in Figure 5.

Principal culverts

There are 13 principal culverts in the scheme comprising precast reinforced concrete box structures. The use of precast boxes enabled these culverts to be built in a very short period of seven months and within the allowable time period specified in the contract. Where required, a mammal ledge was provided on the walls of principal culverts to facilitate mammals to cross the road. A photograph of a typical culvert-type structure is given in Figure 6.

Concluding remarks

The contractor expects to achieve his tight construction programme by close co-operation between the construction joint venture, its subcontractors, designer and using precast concrete elements. The professional working relationship between the client's representative and the project delivery team has also assisted in achieving the project targets completion to date. ■