


ACCESSIBILITY & TRANSPORTS

Project nr 2008-1/049

2nd Partners Meeting
Belfast: 22-23 June 2009


Presentation to Trans-national Workshop
NRA: Maintenance and repair of bridges

Albert Daly
National Roads Authority, IRELAND




European Union
European Regional Development Fund

Investing in our common future



ATLANTIC AREA
Transnational Programme



NRA
An tÚdarás um Bóithre Náisiúnta
National Roads Authority



2nd Partners Meeting
QUB, Belfast 22-24 June 2009



NRA
An tÚdarás um Bóithre Náisiúnta
National Roads Authority

National Roads Authority

- ❑ **Established by Ministerial order under Section 16 of the Roads Act 1993**
- ❑ **Autonomous body whose role is set out in the Act**
- ❑ **Operates within the non-commercial semi-state sector**



Function:
... to secure the provision of a safe and efficient network of national roads ...

Section 16 of the Roads Act 1993



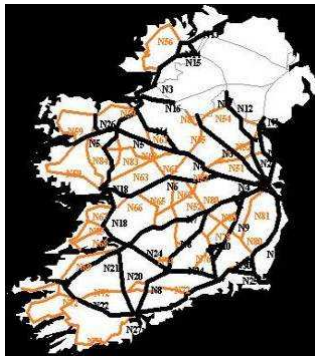
European Union
European Regional Development Fund



ATLANTIC AREA
Transnational Programme

Irish Road Network

- Roads are the dominant mode of internal transport
- Account for 89% of freight transport ...
- ... and 96% of passenger transport



National Road Network (as of end 2006):

National Primary 2,747km

National Secondary 2,679km

TOTAL 5,427km

Contains 2,184 bridges (EIRSPAN)

Carries 46% of Irish traffic



Transport 21 outlines the capital investment framework through which the transport system in Ireland will be developed over the period 2006-15

- Launched 1 November 2005
- €34.4 billion investment in transport infrastructure
- €16 billion Exchequer funding for national roads for the period 2006 - 2015
- Additional €2 billion in private finance (PPP)

Challenges

- Changes in design standards
 - Increasing levels of traffic
 - Deterioration of bridges
 - Failure of bridge components
 - Climate Change



Infrastructure asset

- Pavement
- Bridges/culverts
- Retaining walls
- Tunnels
- Parapets/safety barriers
- Acoustic fences
- Sign gantries
- Lighting columns



Bridges

EIRSPAN is the data base used to co-ordinate and integrate all bridge management activities on the Irish National Road system.

- Launched 2001
- Currently 2,345 structures
- Implementation of Eirspan complete
- Assessment phase commencing
 - Stage I: Assessment to 40 tonne loading
 - Stage II: Further assessment where required

Bridge types

Structure type	Number	% of total
Single span masonry arch	536	23
Multi-span masonry arch	298	13
Concrete slab	682	29
Slab/girder deck	175	7
Box beam deck	68	3
Retaining walls	178	8
Other	408	17
Total	2,345	





EIRSPAN TASK ORDER 165

PRINCIPAL INSPECTION AND INVENTORY GATHERING OF KERRY BRIDGES

Structure Name:

Kenmare Bridge

Structure ID

KY-N71-014.00



Document History Record

Date of Issue	Revision	Prepared	Checked	Approved
15/12/2008	1	MT	MA	USA

National Roads Authority
National Roads Office
Richmond
Glennire
Co. Cork

Fehily Timoney Ramboll
Core House
Poulsboe Road
Cork



NRA		EIRSPAN	Printed	Page	
INSPE		Inspection report	11-12-08	3	
KY-N71-014.00 Kenmare Bridge					
Maintaining Agent:	13 KY - Kerry				
Road:	Killarney - Bantry - Skibbereen - Victoria Cross, Cork				
Side of road:	0				
Plate and Dist.:	220 141				
Region:	3 Munster				
Struct. reg. no.:	1533				
Year of construction:	1936				
Year of reconstruction:					
Primary passage:	Overbridge/Underbridge: 0				
Dir. of change on primary road:	0				
Access equipment needed:	0 Nothing				
Data collected:	Date: 2008.09.12				
	Inspector Initials: MA/MT				
	Checker Initials: MA				
Geographical position:					
Latitude Y:	69919.000	Longitude X:	91082.000	m	
Geometry:					
Number of spans:	2				
Min span length:	48.05				
Max span length:	48.05				
Overall length:	96.10				
Width out-trench:	9.40				
Width of median:	0.00				
Width of footway left:	1.00				
Width of footway right:	2.13				
Width of carriageway:	5.23				
Width kerb-to-kerb:	5.80				
Width of approach:	5.23				
Area:	903.24				
Minimum Parapet Height:	1.06				
Width of Soft Verges:	0.00				
Approach Skew 1:	0.00				
Approach Skew 2:	0.00				
Bridge curved:	(Y/N): N				
Skew:	(Deg): 0				
Span Lengths:					
Span 1:	48.05	Span 6:	0.00	Span 11:	0.00
Span 2:	48.05	Span 7:	0.00	Span 12:	0.00
Span 3:	0.00	Span 8:	0.00	Span 13:	0.00
Span 4:	0.00	Span 9:	0.00	Span 14:	0.00
Span 5:	0.00	Span 10:	0.00		
Superstructure, principal type:					
Standard design:	(Y/N): Y				
Design of cross section:	50 Arch above the deck				
Design of elevation:	70 Suspension Bridge				
Material of primary members:	20 In situ Reinforced Concrete				
Superstructure, secondary type (if applicable):					
Standard design:	(Y/N):				
Design of cross section:	91 Not applicable				
Design of elevation:	91 Not applicable				
Material of primary members:	91 Not applicable				

NRA		EIRSPAN	Printed	Page											
INSPE		Inspection report	11-12-08	3											
KY-N71-014.00 Kenmare Bridge															
Chronological overview:															
Date	Activity	Br	Es	Fo	Fa	En	Wl	Ab	Pl	Bw	Ds	Rs	Rl	Ot	St
2002.03.20	Principal Inspec	2	4	1	2	0	0	0	0	0	1	3	0	-	3
2008.09.12	Principal Inspec	0	3	1	3	0	1	1	1	0	2	3	1	-	3
Last principal inspection:															
Date:	2008.09.12														
Team Leader Name:	Mattí Airaksinen														
Initials:	MS/MT														
Weather:	Overcast														
Temperature:	15														
Traffic: Annual Average Daily Traffic:	6064														
Percentage, light vehicles:	95														
Percentage, heavy vehicles:	5														
Tear for next principal inspection:	2011														
Remark:															
Tear of ADT in 2004. This structure has historic significance and as such, any repairs must be in context with the original design. Any deviation from original materials and/or features would be unacceptable. Repairs to the structure were undertaken in the mid 1980's comprising removal of chloride-contaminated concrete and replacement with fly-ash concrete. The deck soffit was grouted with the soffit beams and slabs being treated with silane and the deck was re-activated. Vertical ties are 0.16m wide and 0.7m															



NRA		EIRSPAN	Printed	Page
INSPE		Inspection report	11-12-08	4
KY-N71-014.00 Kenmare Bridge				
No Component				
Repair work	Com	Mth	Spa	Pho
- Damage description	rtg	rtg	Ins	ton
Type of damage			Qty	Cost
1 Bridge surface				
Surface dressing	2	-		4
Reinstallation of drain gully with inl				
Deck at south side requires surface				
dressing. Some evidence of water				
ponding on deck (Photo 3) - blocked				
gullies which should be cleaned.				
Some dampness staining on underside				
of deck around drainage pipes				
(Photo 4). Some of these pipes are				
too short - recommend these are				
replaced approx 2004.				
Other:				
2 Expansion joints				
ReAsphalt plug joint material (50x10 c	3	-		3
Open cracks in buried joints at				
both north and south abutments				
allowing water to seep into deck				
(Photos 1 and 2). Expansion joint				
looks ok but needs to be cleaned				
out (Photo 3).				
Cracking:				
3 Footways/median				
Pavement on west cracked - was not	1	-		2
properly reinstated when services				
were laid under pavement.				
Cracking:				
4 Parapets/Safety barrier				
Reparis of parapet/guardrail	3	-		4
ReMasonry repointing				
North west edge of parapet concrete				
is cracked (Photo 1). Many of the				
parapet posts have corroded (Photo				
2) and some of the feet corroded				
away (Photo 3). Protective coating				
required on rails (Photo 2).				
Pedestrian refuges have vertical				
cracks (Photo 4). Note:- Repairs				
will have to be in line with				
existing type, and high cost of				
repair has been entered to reflect				
this.				
Material loss / disintegration				
5 Embankments/Retainments				
In good condition, see also	0	+		1
component 6 Photo 1				

Need for inspection and assessment

- **Increased traffic loading**
- **Design/construction faults**
- **Abnormal loads**
- **Deterioration (corrosion, ASR, etc)**
- **Minimise disruptions and closures**

Deterioration



Forms of deterioration

- **Corrosion**
 - steel sections
 - reinforcement
 - cracked/spalled concrete
- **Alkali-silica reaction**
- **Freeze-thaw damage**
- **Sulphate attack**
- **Conversion of HAC**
- **Mechanical damage**

Taking account of deterioration

- Reduced cross-sectional area
- Modified concrete properties
- Modified steel properties
- Modified bond properties
- Modified structural behaviour
- Additional stress
- Condition factor

Bridge rehabilitation/strengthening

- **Component replacement**
 - *Joints and Bearing replacement*
 - *Beam replacement*
 - *Re-decking*
- **Patch repair**
 - *minor concrete repair*
 - *reinforcement replacement*
 - *cracked/spalled concrete*
- **Jacketing (steel or reinforced concrete_**
- **External post-tensioning**
- **Steel plate bonding, FRP strengthening**
- **Near-surface-mounted reinforcement**

Documents

Downloaded at: <http://www.official-documents.co.uk/document/deps/ha/dmrb/index.htm>

Highways Agency documents relating to inspection and maintenance:

- *BD 63/07: Inspection of Highway structures*
- *BD 53/95: Inspection and records for road tunnels*
- *BD 54/93: Post-tensioned concrete bridges. Prioritisation of Special Inspections*
- *BD 54/93: Post-tensioned concrete bridges. Planning, organisation and methods for carrying out Special Inspections*
- *BA86/06: Advice Notes on the non-destructive testing of highway structures*
- *BD 62/07: As-built, operational and maintenance records for highway structures*
- *BD87/05: Maintenance and painting of steelwork*
- *BA72/03: Maintenance of road tunnels*
- *BD 89/03: The conservation of highway structures*

Documents

Downloaded at: <http://www.official-documents.co.uk/document/deps/ha/dmrb/index.htm>

Highways Agency documents relating to structural assessment:

- ***BD 21: The assessment of highway bridges and structures***
- ***BA 16: The assessment of highway bridges and structures***
- ***BD 44: The assessment of concrete highway bridges and structures***
- ***BD 56: The assessment of steel highway bridges and structures***
- ***BD 61: The assessment of composite highway bridges***
- ***BA 51: Assessment of concrete bridges affected by steel corrosion***
- ***BA 52: Assessment of concrete bridges affected by ASR***
- ***BA 38: Assessment of the fatigue life of corroded or damaged reinforcing bars***
- ***BA 79: Management of sub-standard highway structures***
- ***BA 39: Assessment of reinforced concrete half-joints***
- ***BA 81: Whole life assessment of highway bridges and structures***

Documents

Downloaded at: <http://www.official-documents.co.uk/document/deps/ha/dmrb/index.htm>

Highways Agency documents relating to repair/rehabilitation:

- ***BD 27: Materials for the repair of concrete highway structures***
- ***BA 43: Criteria and materials for the impregnations of concrete structures***
- ***BD 48: The assessment and strengthening of concrete bridge supports***
- ***BD 84: Strengthening of concrete bridge supports for vehicle impact using fibre reinforced polymers***
- ***BD 85: Strengthening of concrete highway bridges using externally bonded fibre reinforced polymer***
- ***BA 30: Strengthening of concrete highway structures using externally bonded steel plates***
- ***BD 33: Impregnation of concrete highway structures***
- ***BD 79: Monitoring of substandard bridges***
- ***BA 43: Strengthening, repair and monitoring of post-tensioned concrete bridge decks***
- ***BA 83: Cathodic protection for use in reinforced concrete highway structures***

Ferrycarrig Bridge, Wexford, IRELAND

- Prestressed concrete beam-and-slab bridge
- Located in the South-west corner of Ireland, marine environment
- Offered to DuratiNET Activity 7 (Performance evaluation of repair systems and products) as a case study



Ferrycarrig Bridge, Wexford, IRELAND

- Constructed 1980
- Length 125.6m, 8 equal spans (15.7m)
- Carried N11 single carriageway road over river Slaney estuary
- Precast, prestressed concrete beam-and-slab bridge
- Reinforced concrete piers and cross-heads
- Continuous except centre pier where there an expansion joint
- Integral with abutments
- Piers consist of two separate walls encasing steel tubular piles



Ferrycarrig Bridge, Wexford, IRELAND

History of the structure:

- Principle Inspection carried out in 2002 using EIRSPAN procedures
- All components visually examined
- Structure in fair condition



Except for...

- Extensive cracking found in cross-heads and south abutment
- Crack widths up to 3.5mm
- Larger cracks at exposed end of cross-heads
- Cracking not attributed to any specific structural mechanism

Ferrycarrig Bridge, Wexford, IRELAND

History of the structure, continued:

- Special Inspection carried out in 2004 to determine cause and extent of cracking, leaching and staining
- Detailed survey and crack mapping
- Small number of 50mm cores taken
- Structural assessment to determine load carrying capacity
- Also examine integrity of waterproofing and adequacy of parapets

Conclusions were:

- Serious cracking (0.1mm - 3.5mm) on all exposed surfaces
- Cracking did not follow line of reinforcement, therefore not corrosion induced
- Cores indicated cracks extended past reinforcement and were not tapered indicating shrinkage or early thermal contraction

Ferrycarrig Bridge, Wexford, IRELAND

History of the structure, continued:

Width and depth of cracks raised concerned about the durability of the structure and it was decided to carry out a detailed structural assessment to determine:

- Deterioration mechanisms
- Residual carrying capacity
- Need for rehabilitation

Chloride ion content, cement content, carbonation, cover, half cell tests were also carried out on representative areas of:

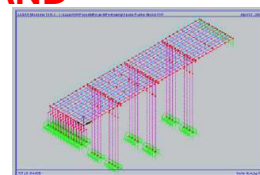
- Deck
- Cross-heads
- Parapets

Ferrycarrig Bridge, Wexford, IRELAND

Results of assessment:

DECK

- 40/44 tonne HA capacity + 45 units of HB
- SLS: minor levels of overstress at top of precast beams at piers



PIERS

- Sufficient flexibility to relieve creep and shrinkage strain in deck
- Insufficient reinforcement to resist transverse shrinkage forces in cross-head
- Torsion capacity in cross-head may also have been exceeded (possibly during construction)

ABUTMENTS

- Sufficient capacity

Ferrycarrig Bridge, Wexford, IRELAND

Conclusions:

- Cracking in cross-head due to insufficient reinforcement for shrinkage and torsion: strengthening required
- Chloride levels indicated high concentration in cover zone, decreasing rapidly with depth
- Waterproofing system failed throughout: replacement required
- Centre joint failed: replacement required
- All mechanical bearings had failed: replacement required



THANK YOU