HIGHWAYS AGENCY

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MAC Area 9 – Midland Links Motorway Viaducts – Development of repair strategies including Electrochemical Techniques

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UK Bridge Owners Forum
University of Cambridge
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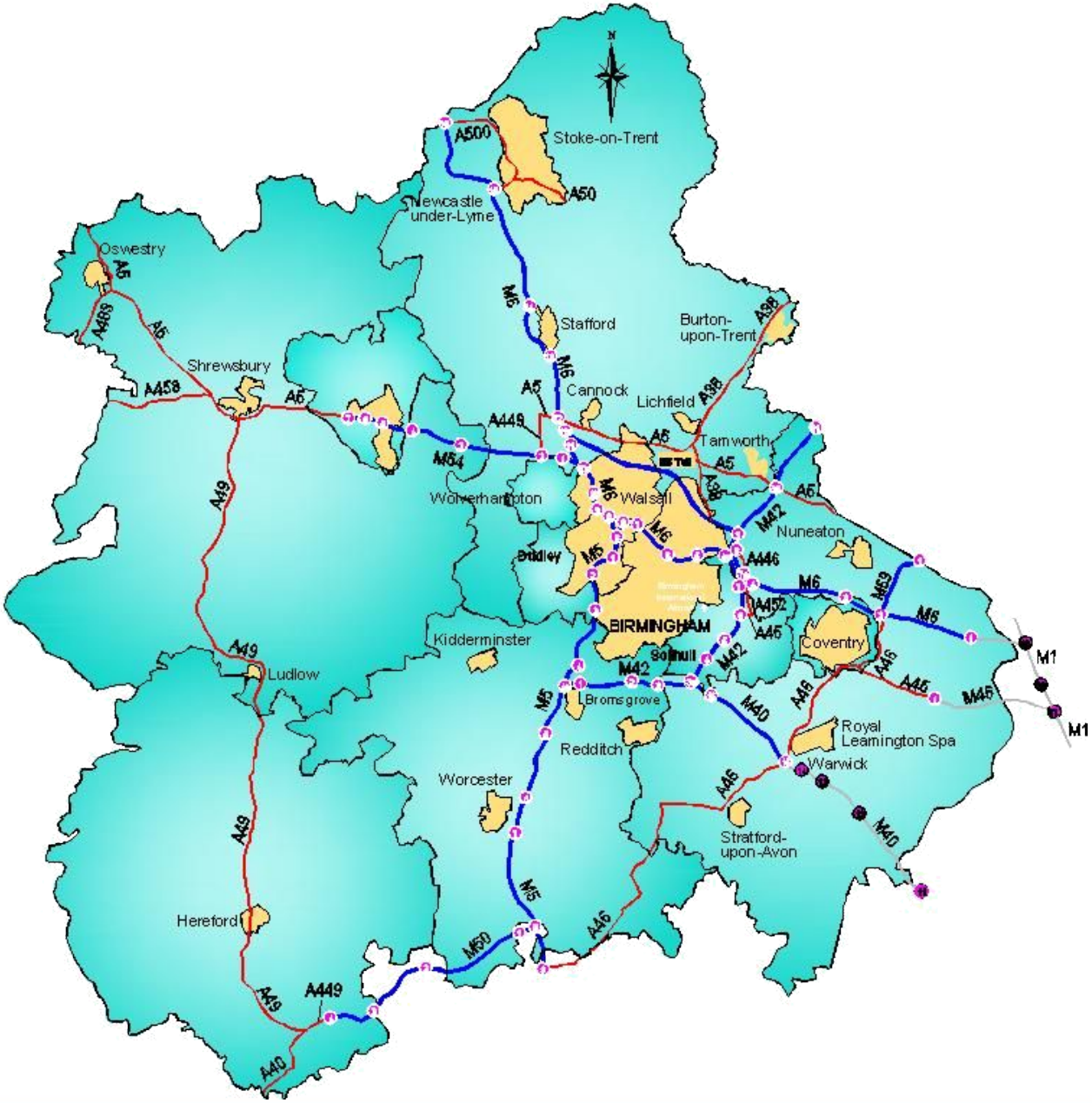
Contents

Importance of Midland Links Motorway Viaducts

Problems facing MAC 9 Structures

- Over 2700 Structures including Midland Links
- Very Highly Trafficked Network
- Much of the Network was built in late 60's / early 70's – lots of Reinforced Concrete.
- Many 'vulnerable structures' including half and hinge joints
- Huge maintenance liability for the HA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Stafford
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Cannock
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Burton-upon-Trent
Lichfield
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Tamworth
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Wolverhampton
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Dudley
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BIRMINGHAM
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Coventry
Kidderminster
Solihull
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Ludlow
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Bromsgrove
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Royal Leamington Spa
Redditch
Warwick
Worcester
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A45
Stratford-upon-Avon
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Hereford
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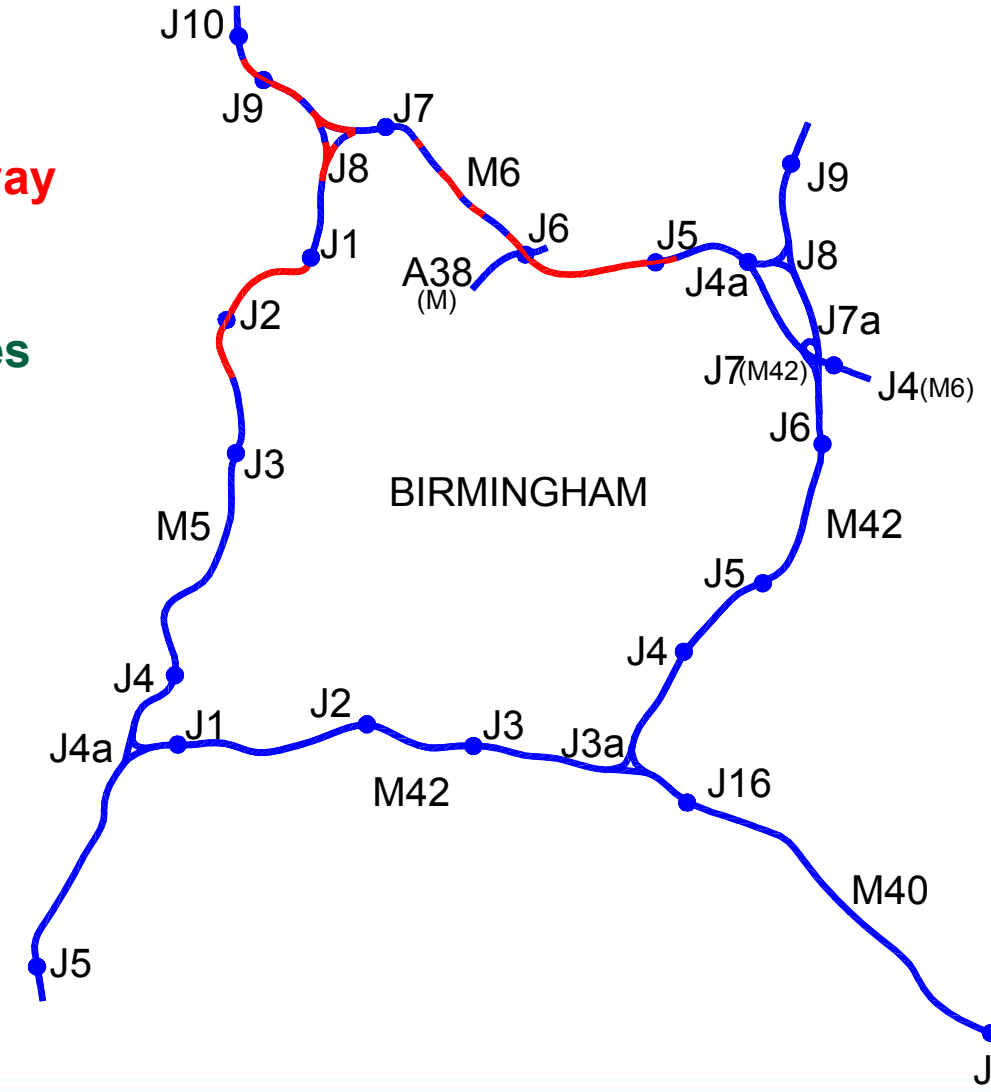
The strategic importance of the Midland Links Viaducts compared with other HA assets

21Km of elevated motorway
1302 crossbeams
3600 columns
Over 300 other structures



The Daily Telegraph

LONDON, WEDNESDAY, JUNE 2, 1965. and Morning Post Printed in LONDON and MANCHES

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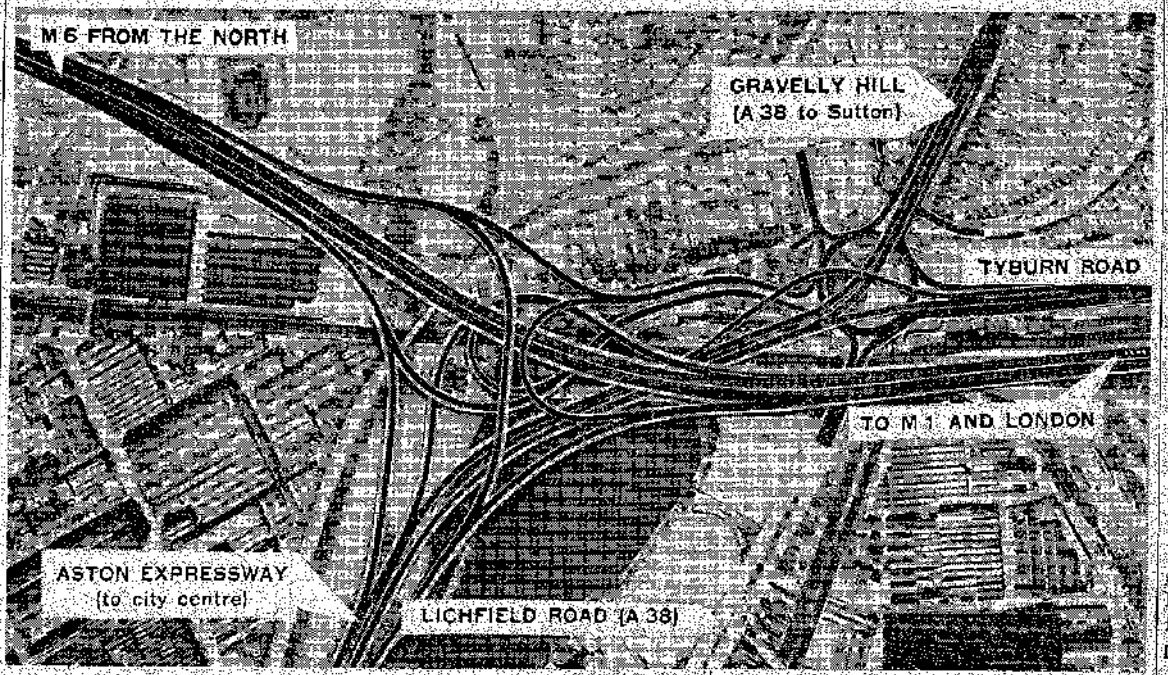

A model of an 80ft.-high eight-level junction to be built on the Midland motorway at Gravelly Hill, Birmingham, to connect the M.6 with the city's central and northern areas, and eventually link the M.6 with the M.1. [Report—P26]

Sir Alec sees 'our duty

NATO arms meeting

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Q. How long are the Midland Links Viaducts?




Midland Links Viaducts

21 km

1.6 km	2.8 km	2.2 km	1.0 km	2.8 km


Severn Bridge


Thelwall Viaducts


Humber Bridge


Tinsley Viaduct


QE2 Bridge

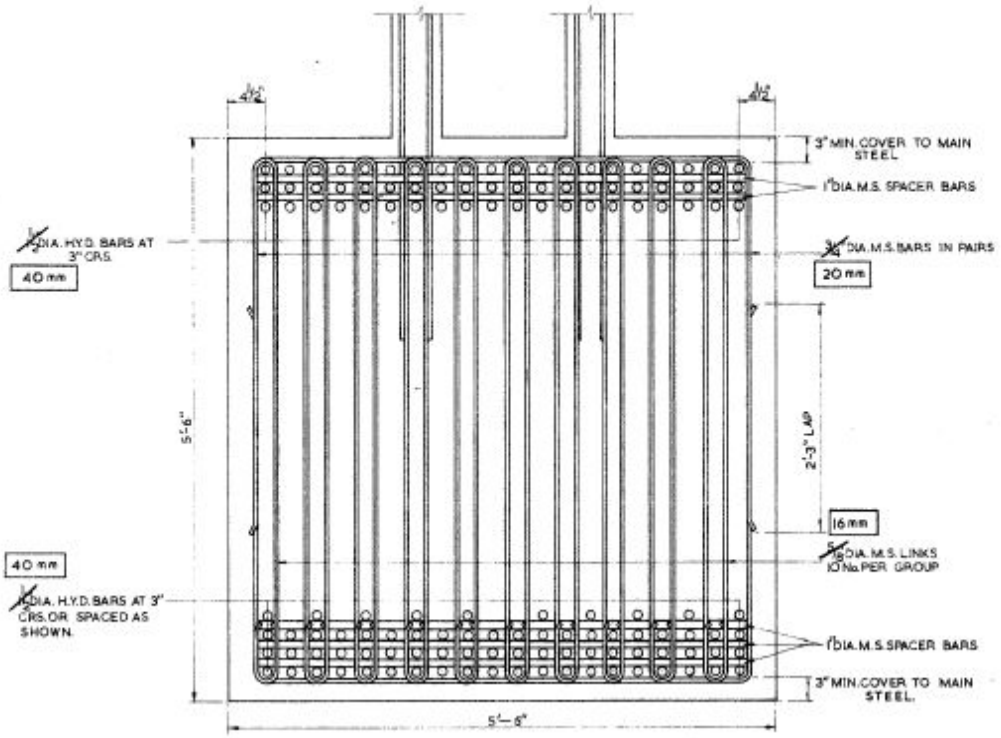
A. Twice as long as all these put together!!

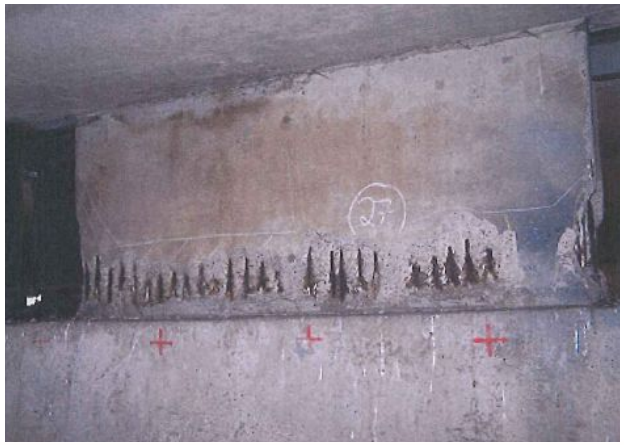
Gravelly Hill – An Iconic National Infrastructure Asset

Why are the Midland Links Viaducts so vulnerable?

Why are they vulnerable?

- There are original design limitations affecting the long term durability:
  - Multi-span viaducts that are simple supported - 1,302 bridge joints over 21km
  - Relatively thin pavement thicknesses
  - Lack of positive drainage facilities to the crossheads below the expansion joints
  - Poor detailing to key structural components
  - Shortages of the specified materials at the time of construction
  - Elements of poor workmanship/supervision which was prevalent at the time of construction during the UK's motorway construction boom
- Significant damage from chloride ingress in the early years
  - It is recorded that the original buried bridge joints failed within 5 years of opening
- The high intensity of use by HGV's; these vehicles contribute most wear and tear to bridge assets
- No 'Design for Maintenance'


4½"
4½"
3" MIN. COVER TO MAIN STEEL
1" DIA. M.S. SPACER BARS
½" DIA. H.Y.D. BARS AT 3" CRS.
40 mm
⅜" DIA. M.S. BARS IN PAIRS
20 mm
5'-6"
2'-3" LAP
16 mm
⅜" DIA. M.S. LINKS 10 Nos. PER GROUP
40 mm
½" DIA. H.Y.D. BARS AT 3" CRS. OR SPACED AS SHOWN.
1" DIA. M.S. SPACER BARS
3" MIN. COVER TO MAIN STEEL.
5'-6"

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14/06/2010

Emergency propping

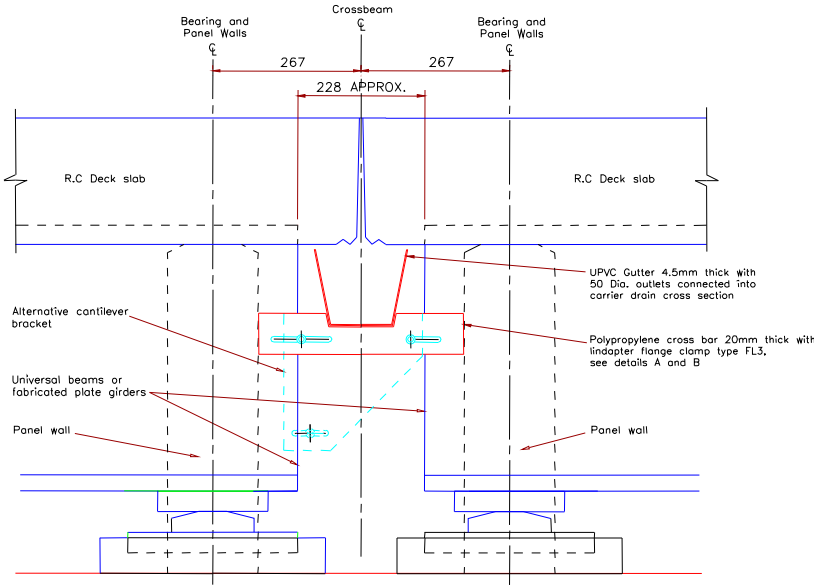
Development of Repair Strategies

Developments of repair techniques

• The Corrosion Problem – identified from PI,s	1979 -1983
• Initial Preventative Measures – gutters, Urea, joints	1983 -1987
• Repair Solutions	1985 -1990
• Cathodic Protection (CP) Trials	1986 -1989
• CP First Contract	1990
• Initial Strategy Development	1988-1990
• Initial Repair Programme	1990-2000
• Risk Based Strategy Development	1997-1999
• Repair Programme	1999-2025?

Initial Repair Strategy – Condition Based

Rating	Condition and repair type
1A	Original condition or newly repaired
1B	Chloride present but no active corrosion – coating applied (silane)
2	Active corrosion due to chlorides, but no delamination – CP
3	Active corrosion and delamination – Temporary support for repair under live traffic load, apply CP or concrete replacement
4	Extensive deterioration – requires interim measures (temporary support, load restriction) element replacement



SECTION A - A THROUGH

NTS

(Type U shown – Type V and N similar)

Conductive Paint Anodes

Discrete anodes

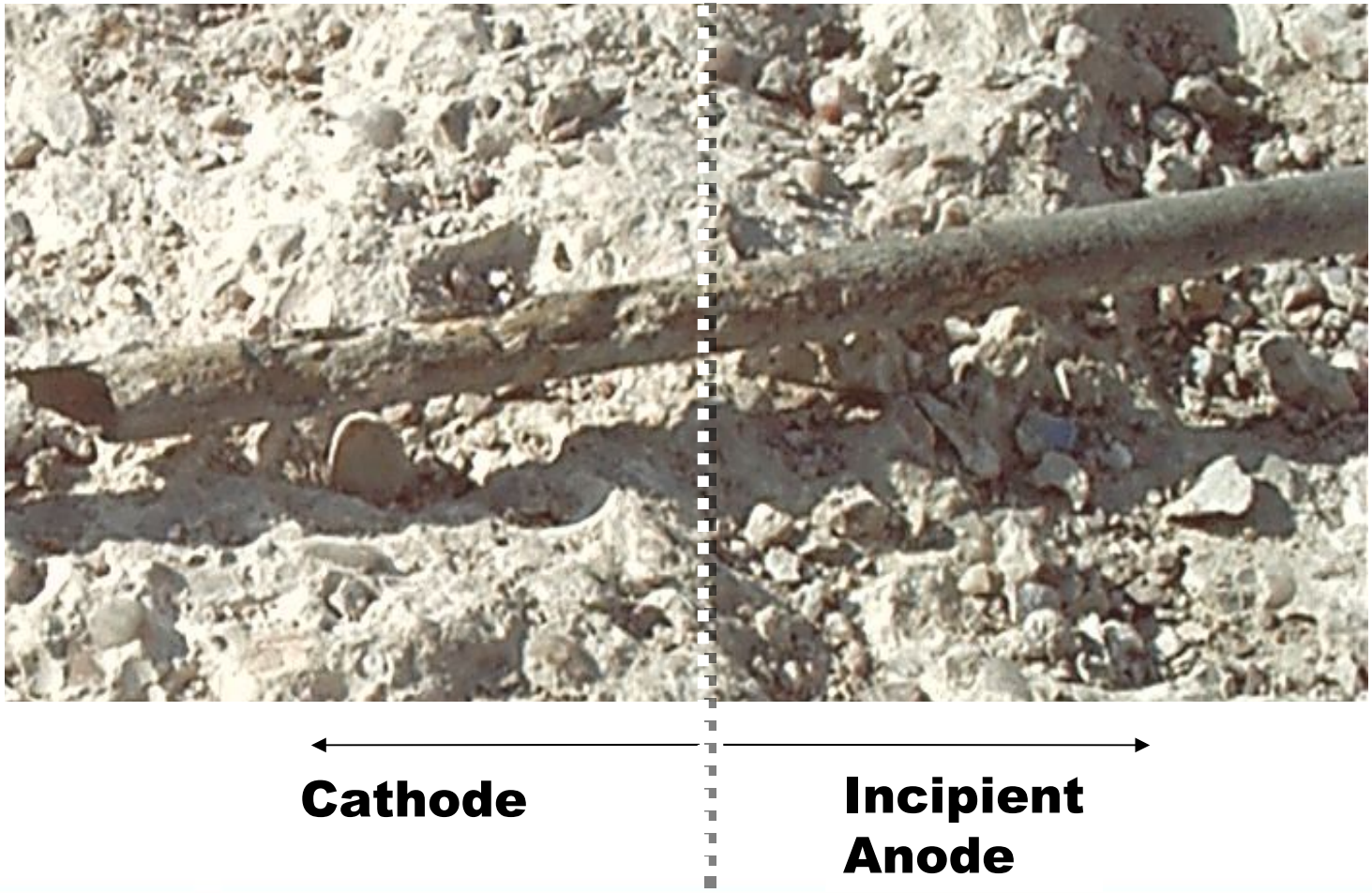
Titanium mesh anodes

Electrochemical Repair Techniques – Current Status

Repair Methods

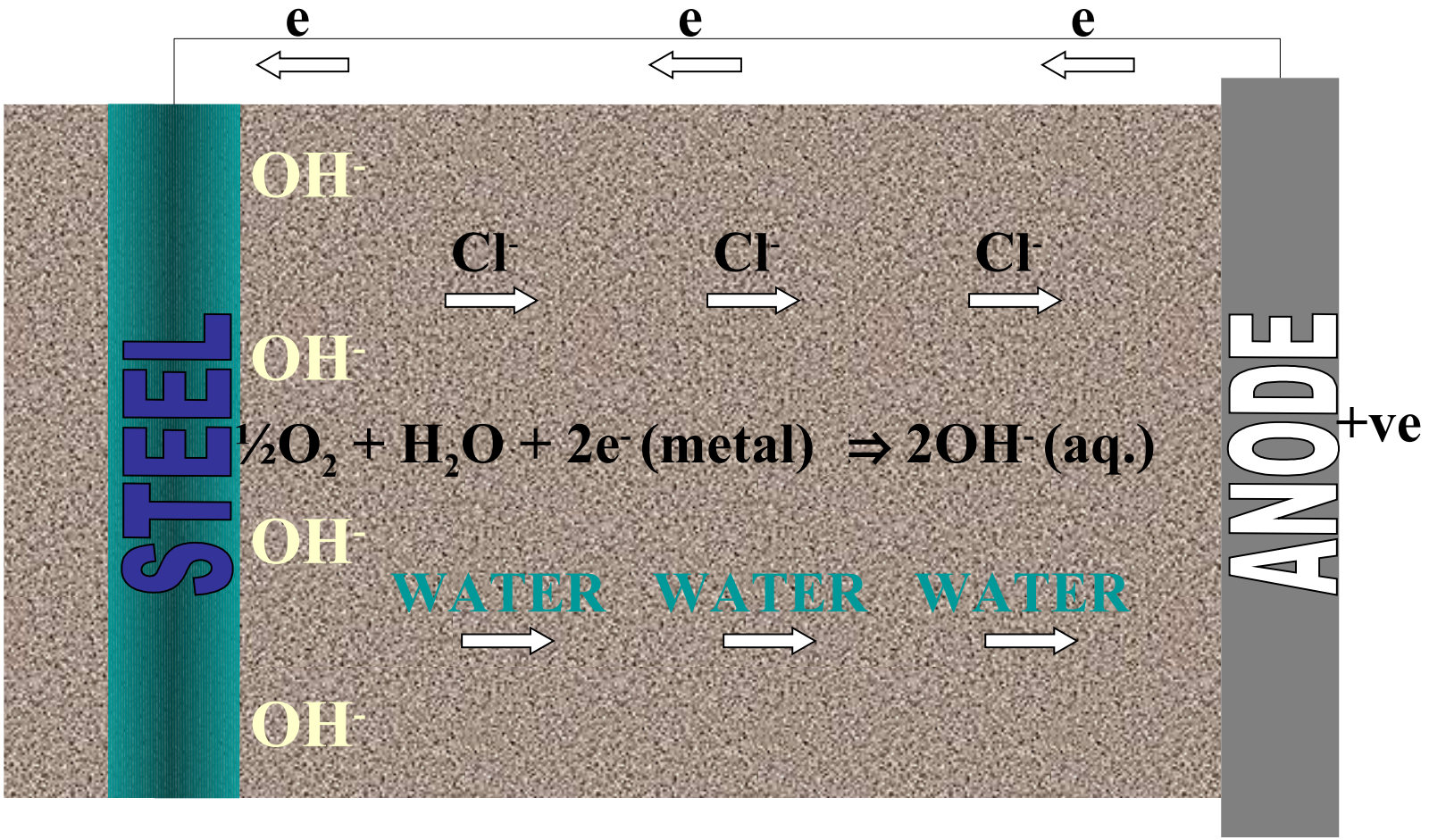
- Reconstruction
- Patch Repair
  - may not work for chloride-induced corrosion
  - risk of ‘incipient anodes’
- Electrochemical Techniques
  - Inhibitors
  - Cathodic Protection
  - Re-Alkalisation
  - Chloride Extraction

Conventional Patch Repair



Incipient Anode Effect

Electrochemical Repair



Electrochemical Repair (cont.)

- Treat a large area of structure, not just patch up corroding areas
- No ‘incipient anode’ problem
- Cheaper and easier than conventional repair in the long term
- Require specialist knowledge
- Special cares required when used on pre-stressed structures and ASR affected structures

Cathodic Protection

- Stops rust, using electrochemistry

- Types of cathodic protection
  - Sacrificial CP
  - Impressed current CP

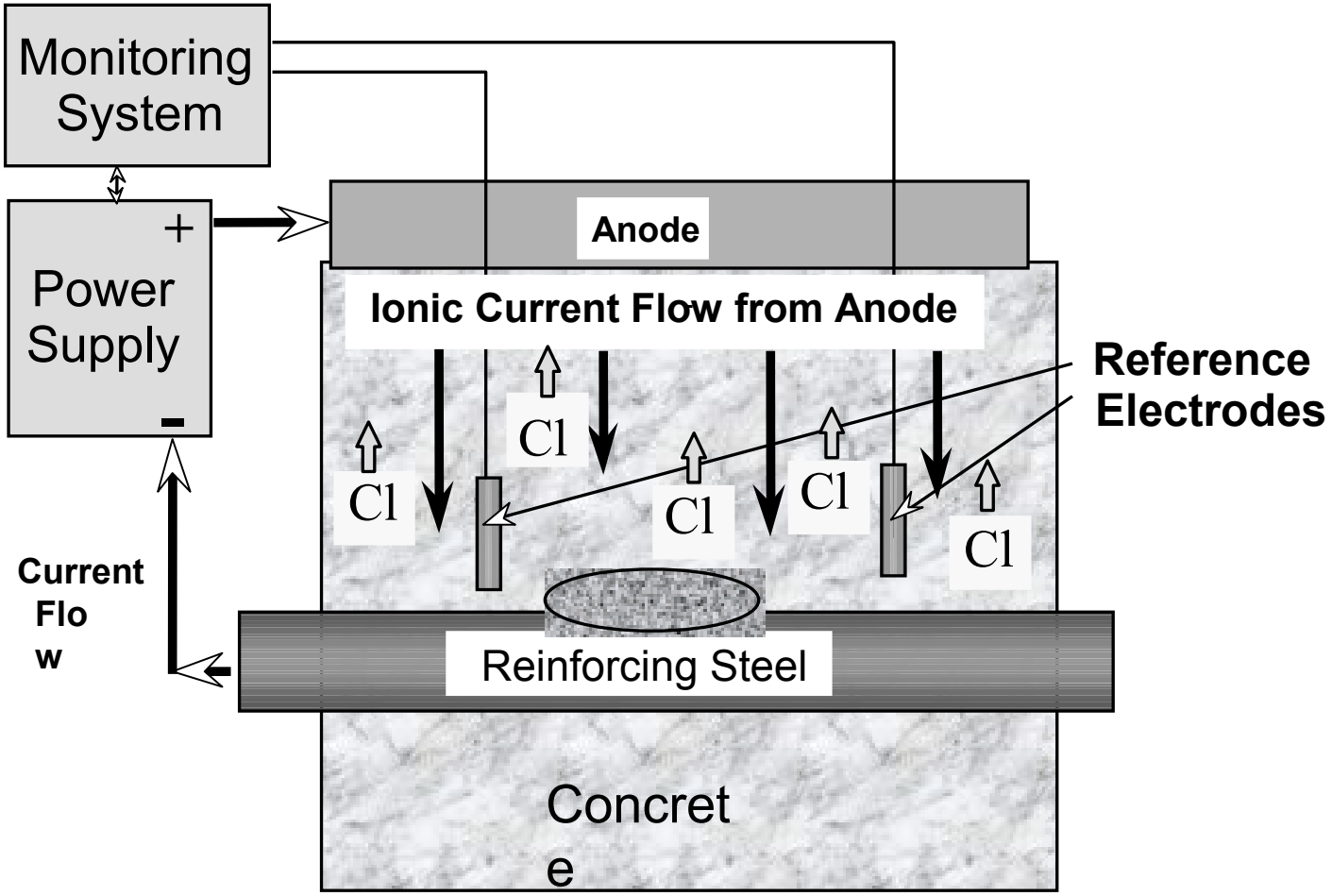
- Different systems available
  - Surface
  - At depth

Sacrificial CP

- Ultimate retro solution (1824).
- Attractive due to simplicity.
- Power and longevity are main limitations.
- Innovative design and better chemistry make wider application possible.
- Release of zinc and aluminium metal ions may prevent use in certain applications.

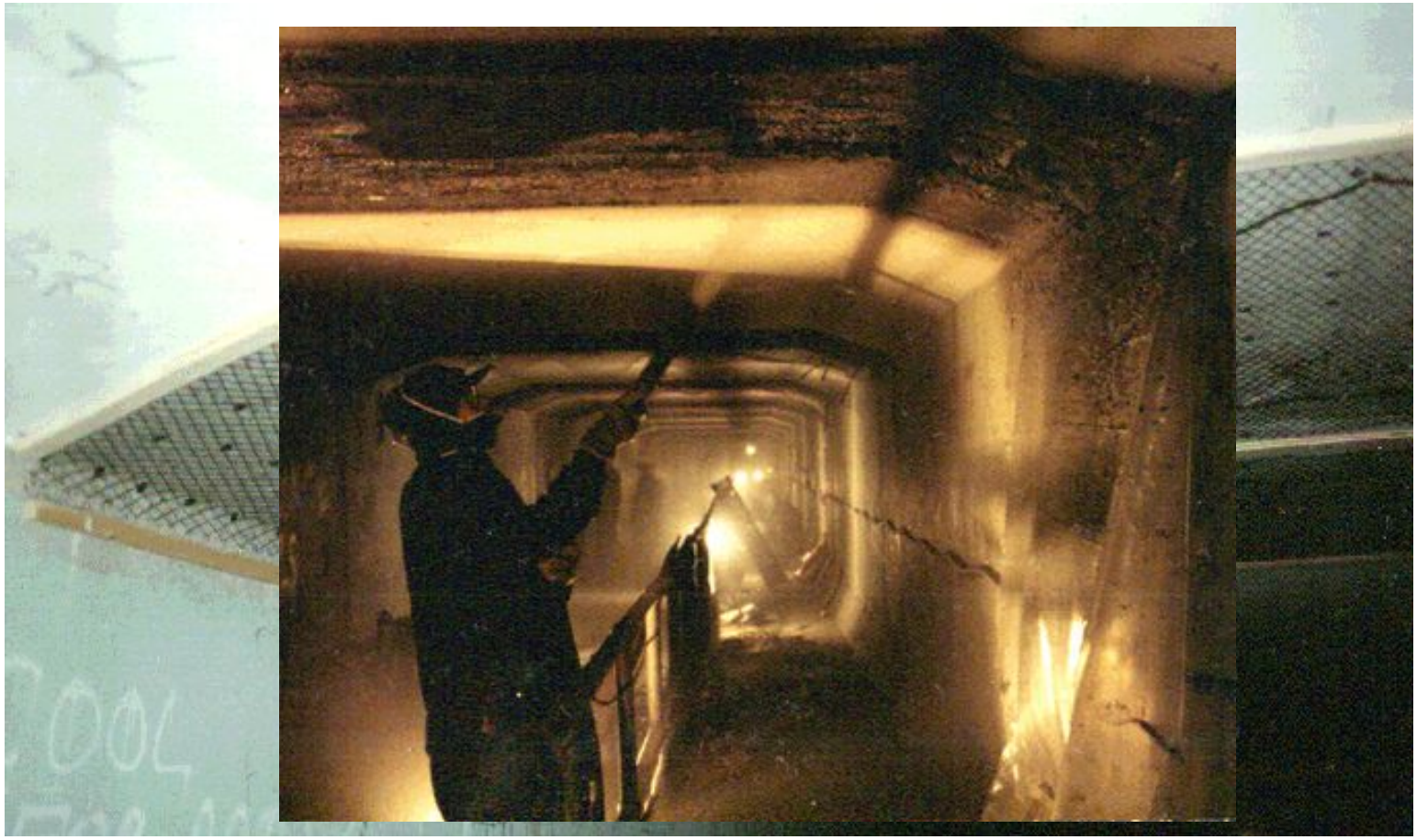
Sacrificial CP

Impressed Current Cathodic Protection (ICCCP)



Cathodic Protection (Discrete Anode)

Cathodic Protection
(Mesh and Sprayed overlay)



Cathodic Protection (Conductive Coating)

Cathodic Protection (Conductive Cementitious Overlays)

Cathodic Protection
(Thermal Sprayed Zinc)

THE HIGHWAYS AGENCY

SCOTTISH EXECUTIVE DEVELOPMENT DEPARTMENT

THE NATIONAL ASSEMBLY FOR WALES
CYNULLIAD CENEDLAETHOL CYMRU

THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

Cathodic Protection for Use in Reinforced Concrete Highway Structures

Summary: This Advice Note gives guidance on the selection and installation of cathodic protection systems for the corrosion protection of reinforcement in highway structures. It has been produced in partnership with the Corrosion Prevention Association.

EUROPEAN STANDARD **EN 12696**

NORME EUROPÉENNE

EUROPÄISCHE NORM March 2000

ICS 77.060; 91.080.40

English version

Cathodic protection of steel in concrete

Protection cathodique de l'acier dans le béton — Kathodischer Korrosionsschutz von Stahl in Beton

This European Standard was approved by CEN on 12 December 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

BRITISH STANDARD

BS EN 15257:2006

Cathodic protection — Competence levels and certification of cathodic protection personnel

The European Standard EN 15257:2006 has the status of a British Standard

ICS 77.060

Budget Cost and Anode Performance Information
Data is extracted from CPA Technical Note 12

Conclusions

- Concrete deterioration and repair is complex
- Deterioration should be managed to minimise expenditure
- Electrochemical repairs and particularly cathodic protection now provides long term repair solution
- New anode systems developed which allow installation in more difficult situation
- Planned maintenance brings comfort to owners and operators of structures

References And Standards

- BA 83/02: Cathodic Protection for use in reinforced concrete highway structures
- BSEN12696:2000 Cathodic Protection of Steel in Concrete
- BSEN 15257:2006 Training and Certification of Cathodic Protection Personnel
- Corrosion Prevention Association - Technical Notes 1 - 12
- Highways Agency Draft Specification for Cathodic Protection of Highway Structures
- Concrete Society Technical Reports 36 and 37 – Cathodic Protection of Steel In concrete including Model Specification – Currently been prepared

References And Standards (Cont'd)

- NACE SP0290 – Impressed current cathodic protection of reinforcing steel in atmospherically exposed concrete structures
- NACE SP0107 – Electrochemical realkalization and chloride extractions for reinforced concrete
- NACE various test method for impressed current anodes and conductive coating
- BS EN 1504, Products and systems for the repair and protection of concrete structures

Any Questions?