Cathodic Protection of Early 20th Century Steel Framed Buildings

By

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Some of our most prestigious landmark buildings of the early 20th century are steel framed

Major department stores, hotels civic buildings etc. in London, Birmingham, Manchester and elsewhere

Now suffering from corrosion of steel frame

Principles of Conservation

- Rule 1 – There are no rules! A flexible approach is required, not adherence to rules.
- Rule 2 – If you've done it before, doesn't mean you can do it again.
- Rule 3 – Just because you don't like a building doesn't mean you don't need to care for it.

Principles of Conservation

- All historic fabric is precious
  - NOT JUST THE ORIGINAL
- Intervention should be avoided if at all possible
  - THEREFORE MINIMUM INTERVENTION
- Necessary intervention should be reversible
- It should be in addition to the existing structure not replace it
- Intervention should be carried out with sympathetic materials (good engineering)
- Avoid destroying historical evidence
- Make clear modern changes while being sympathetic

Guidelines for satisfying the ideals of Conservation

- Grade 1 and 2* it is compulsory to involve EH
- Grade 2 is responsibility of Local Authority, although they often include EH in the process.
- Older buildings (pre 1840) are deemed potentially of historic interest hence EH will often be consulted even if not listed.
- The above applies to England & Wales. Other countries may have different categories and authorities, but principles are broadly the same.

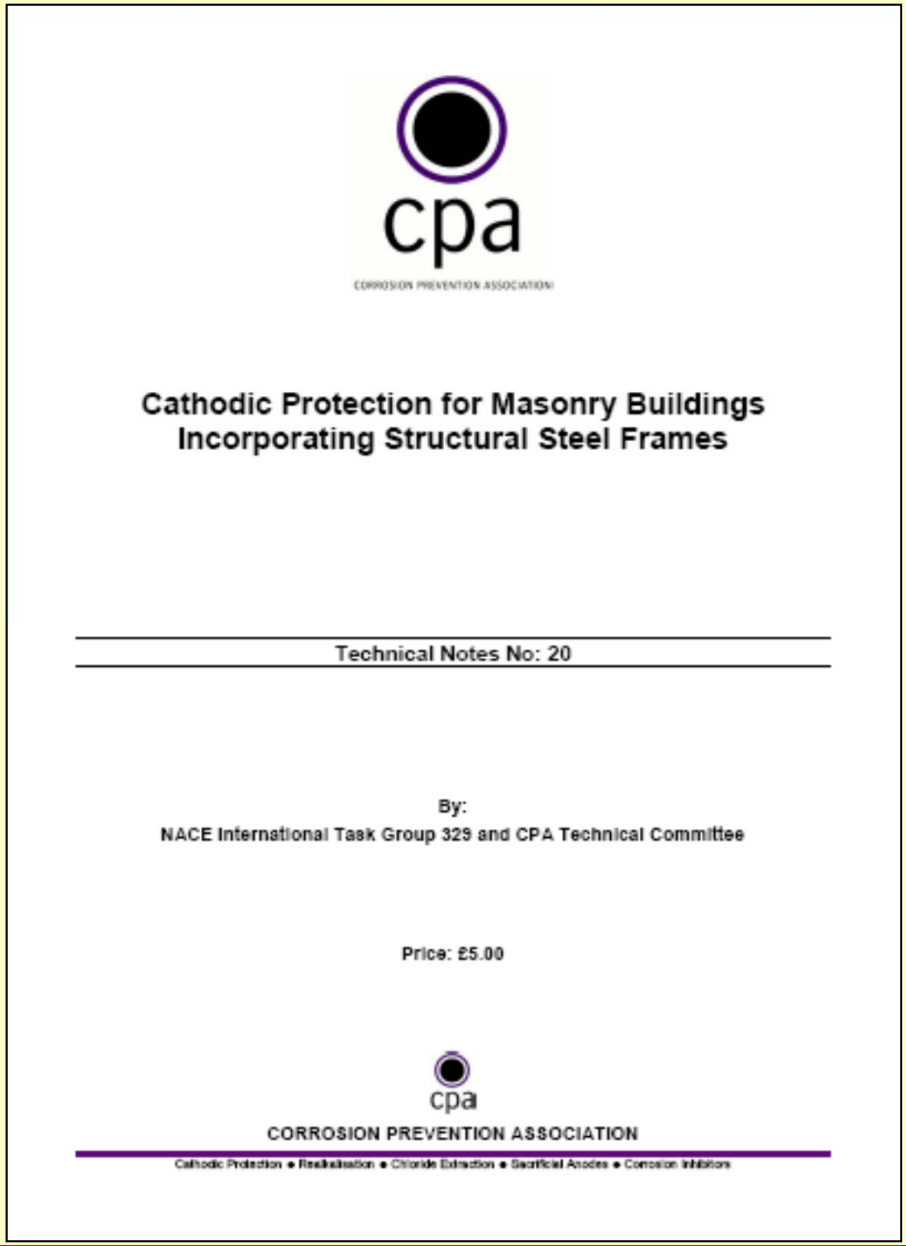
Guidelines for satisfying the requirements of conservation

- Pre application meeting with Regional staff.
- Historic Buildings Inspector.
- Historic Buildings Architect.
- Conservation Engineer
- Consider having a project “Conservation Steering Group” of experts & stake holders

Don’t say
“It’s only the façade that’s listed”

Current regulations list the building without categorising what part. Each building is unique and listed for its own unique reason.

Forthcoming listing procedures will identify more clearly why the building is listed.



cpa

Corrosion Prevention Association

Corrosion Assessment Methods for Steel Frames

- Reference Electrode (Half Cell) Potential Mapping
- Corrosion Rate (Polarisation Resistance)
- Electrical Resistivity
- Carbonation Depth
- Chloride sampling & profile
- NOTE – PERMISSION REQUIRED FOR DESTRUCTIVE EXAMINATION OF LISTED BUILDINGS

Investigation Methods

- Radar
- Infra Red
- Ultrasonics
- Displacement measurements
- Crack monitoring
- Defect Monitoring

Cover Meter used to find depth of steel band which was jacking up brick courses

Problem was cover depth and failed drainage

LPR Meter for steel in concrete or mortar

- From a total of 186 readings
- Assume 1 µm/year section loss
- = 7 µm/year brick movement
- 6% of readings showed >1 mm brick movement in less than 50 years
- High rates concentrated near parapet/roof level and north elevation

Resistivity Meter
4 probe Wenner

CONCRETE

> 20kohm.cm

= Low Corrosion

10 - 20kohm.cm

= Low - Mod Corrosion

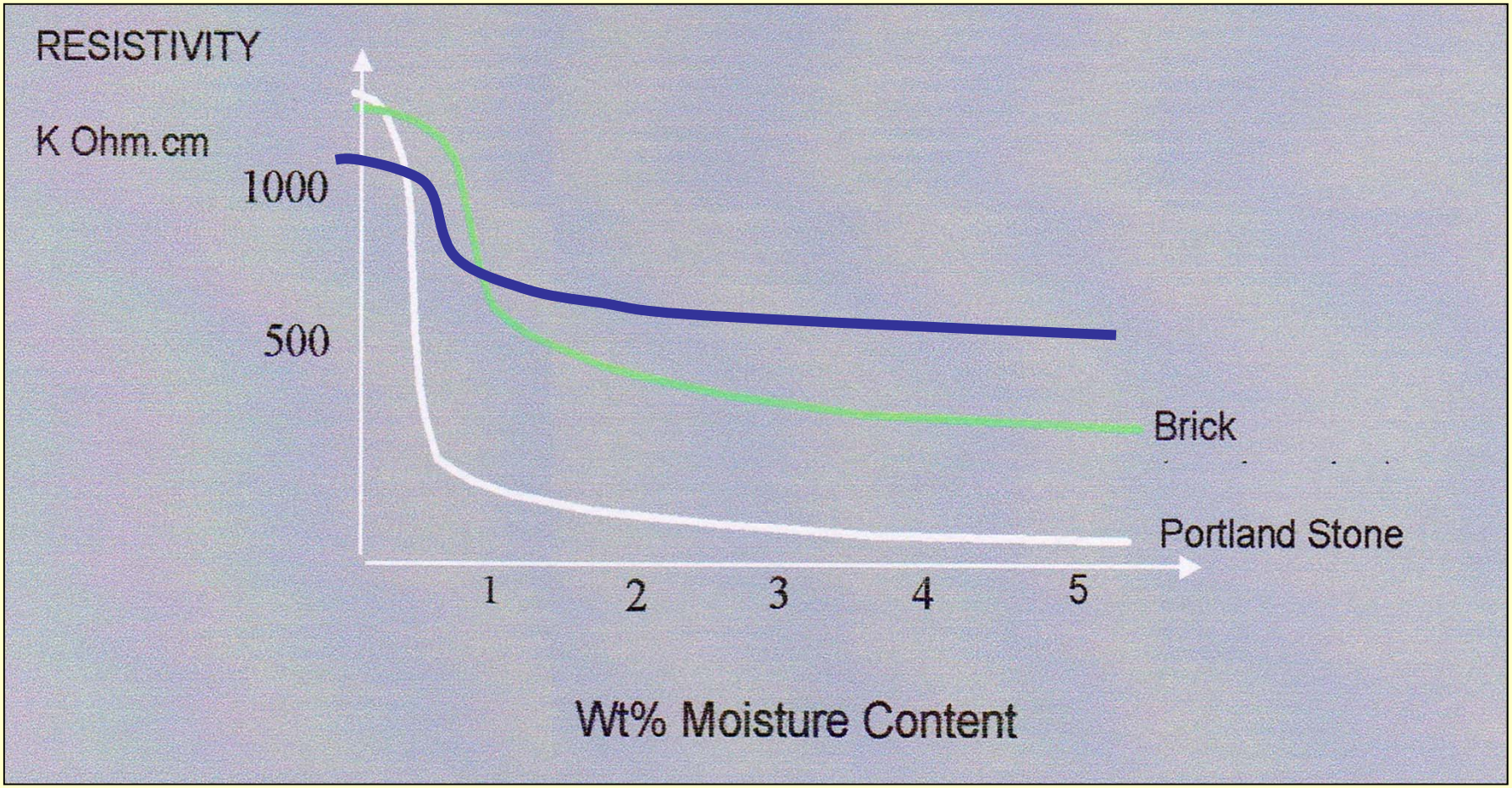
5 - 10kohm.cm

= High Corrosion

<5kohm.cm

= Very High Corrosion

Most masonry materials have resistivities that exceed 1 MΩ.cm when moisture content falls below 2% and in the range 100 to 300 kΩ.cm at higher moisture content.



Repair Options

- Exclude the water
  - Drainage
  - Flashings
  - Repointing
- Strip cladding, treat steel and reclad
- Apply impressed current cathodic protection

Impressed Current Cathodic Protection

- Connect all steel together or isolate it
- Only repair where there is damage
- Divide into zones
- Apply anodes and reference electrodes
- Wire to 10-20V DC power supply
- Apply approximately 5mA/m^2 of surface
- Design and operate according to BSEN12696:2000

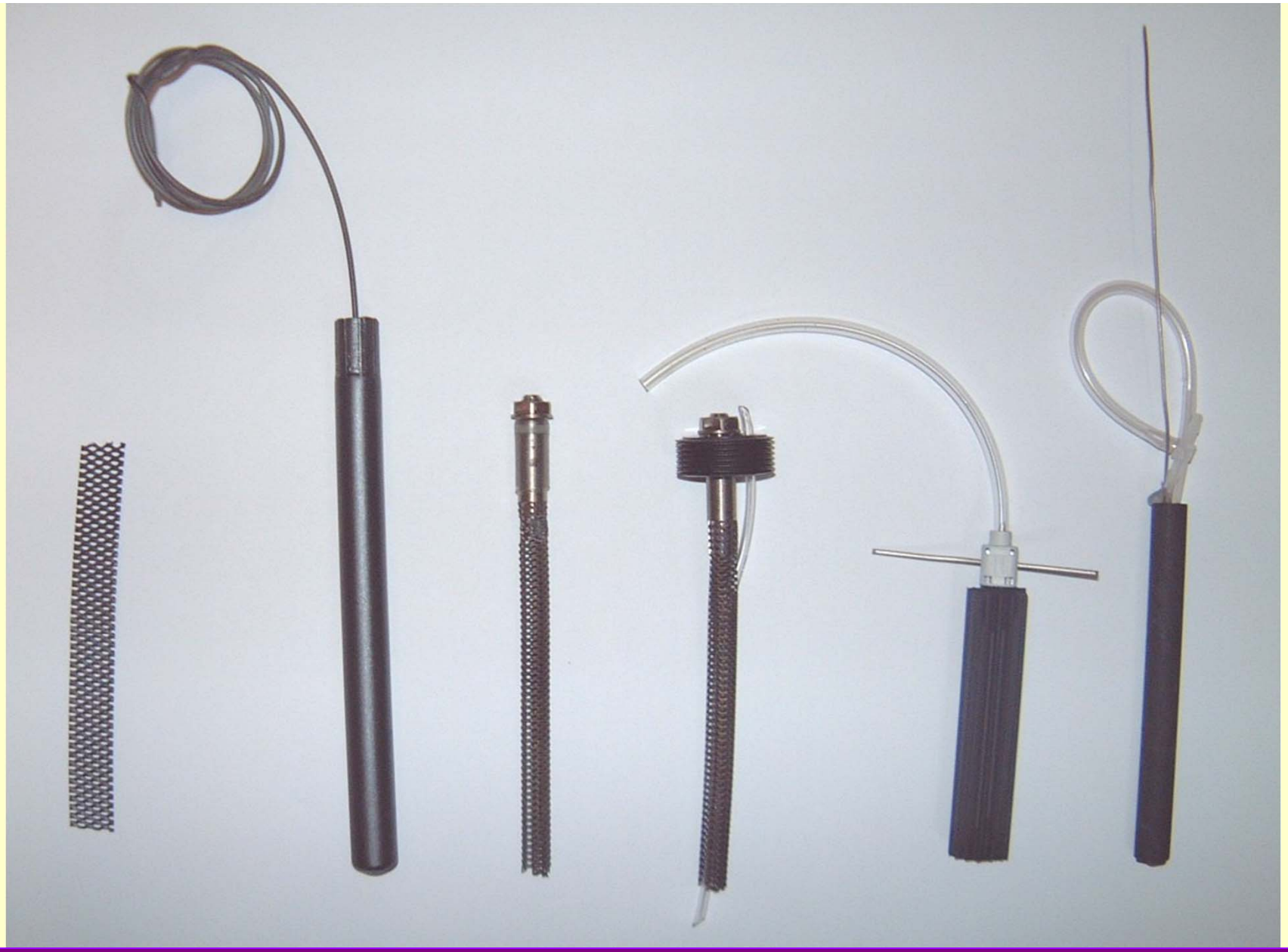
Impressed Current Cathodic Protection Components

- Anodes –
  - Ribbons in joints or probes in holes
  - Different zones to control different conditions
- Reference electrodes
  - Measure the steel potential to ensure it is protected
- Cables
  - From anode zones, steel, and reference electrodes
- Power Supply
  - Typical 12-20V, 1A DC multizone supply
- Monitoring System
  - Local logging or remote control and monitoring

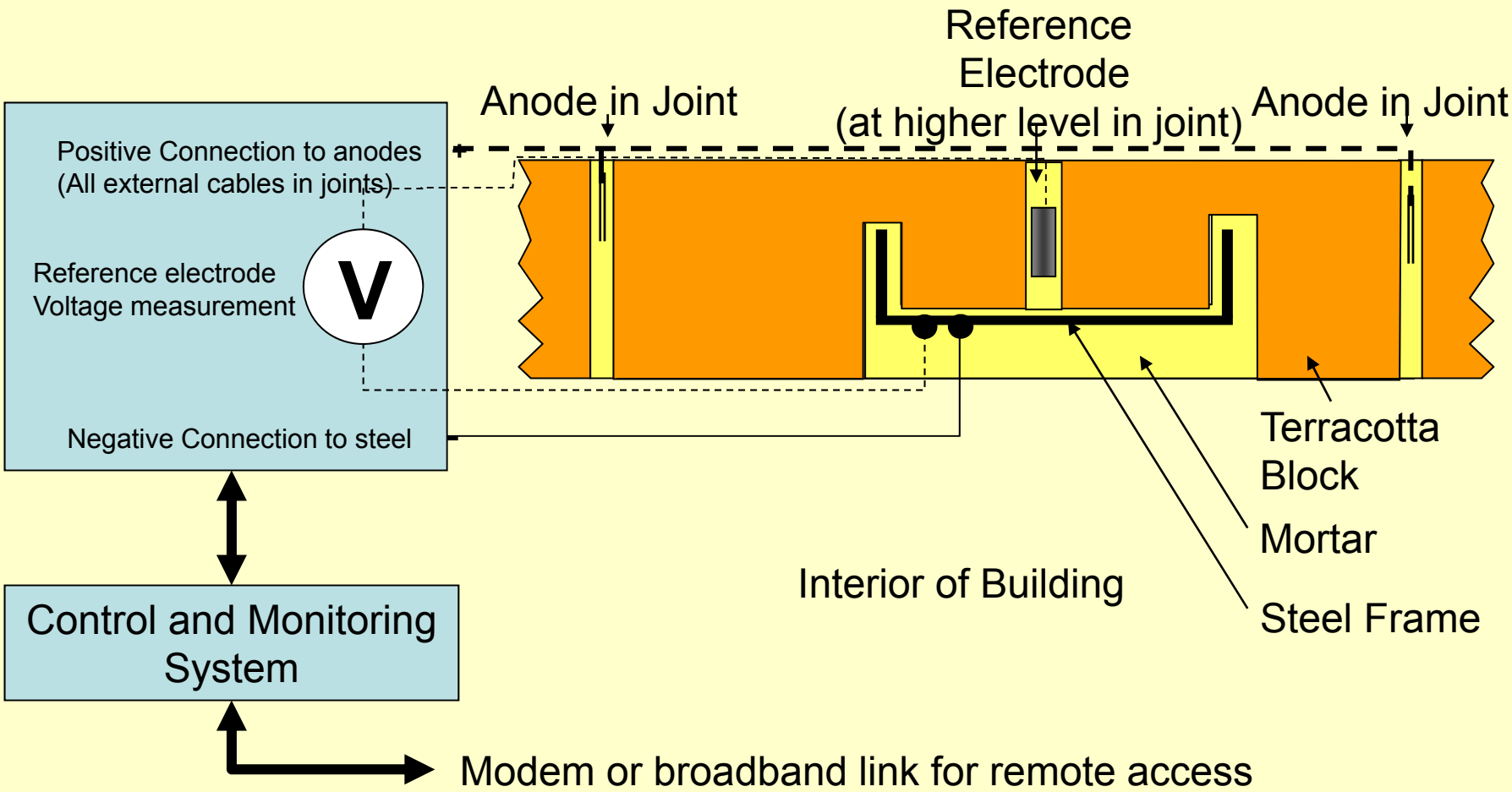
Impressed Current Cathodic Protection Pros & Cons

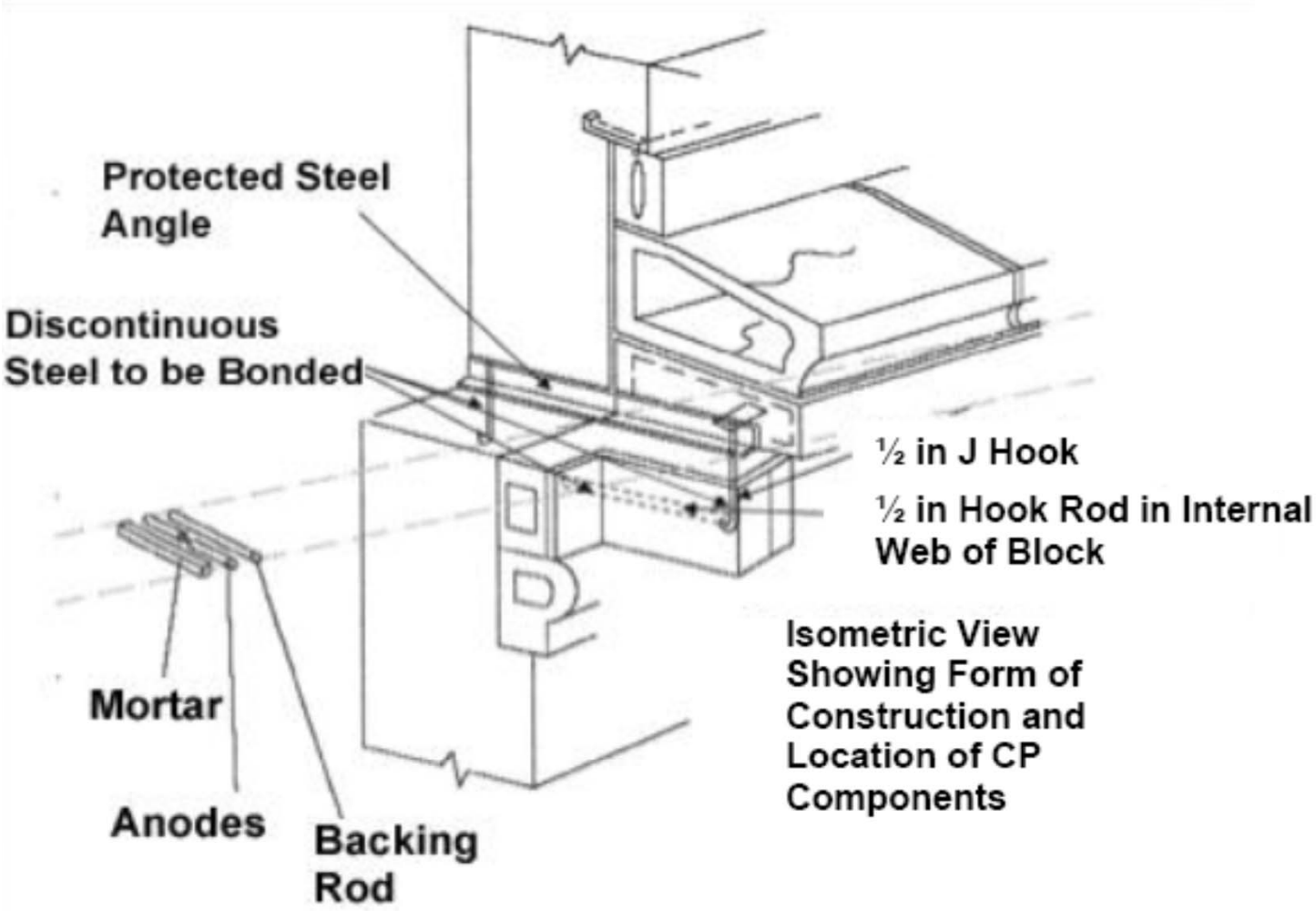
- Wide Range of Anodes
- Well Established Technique
- Well Established Standards
- Many expert UK Contractors/consultants
- Continuous monitoring to show it works

- Requires a continuous power supply
- Requires continuous monitoring
- High first cost
- Highly technical
- Can be hard to hide anodes
- Must bond all steel together
- Possible staining

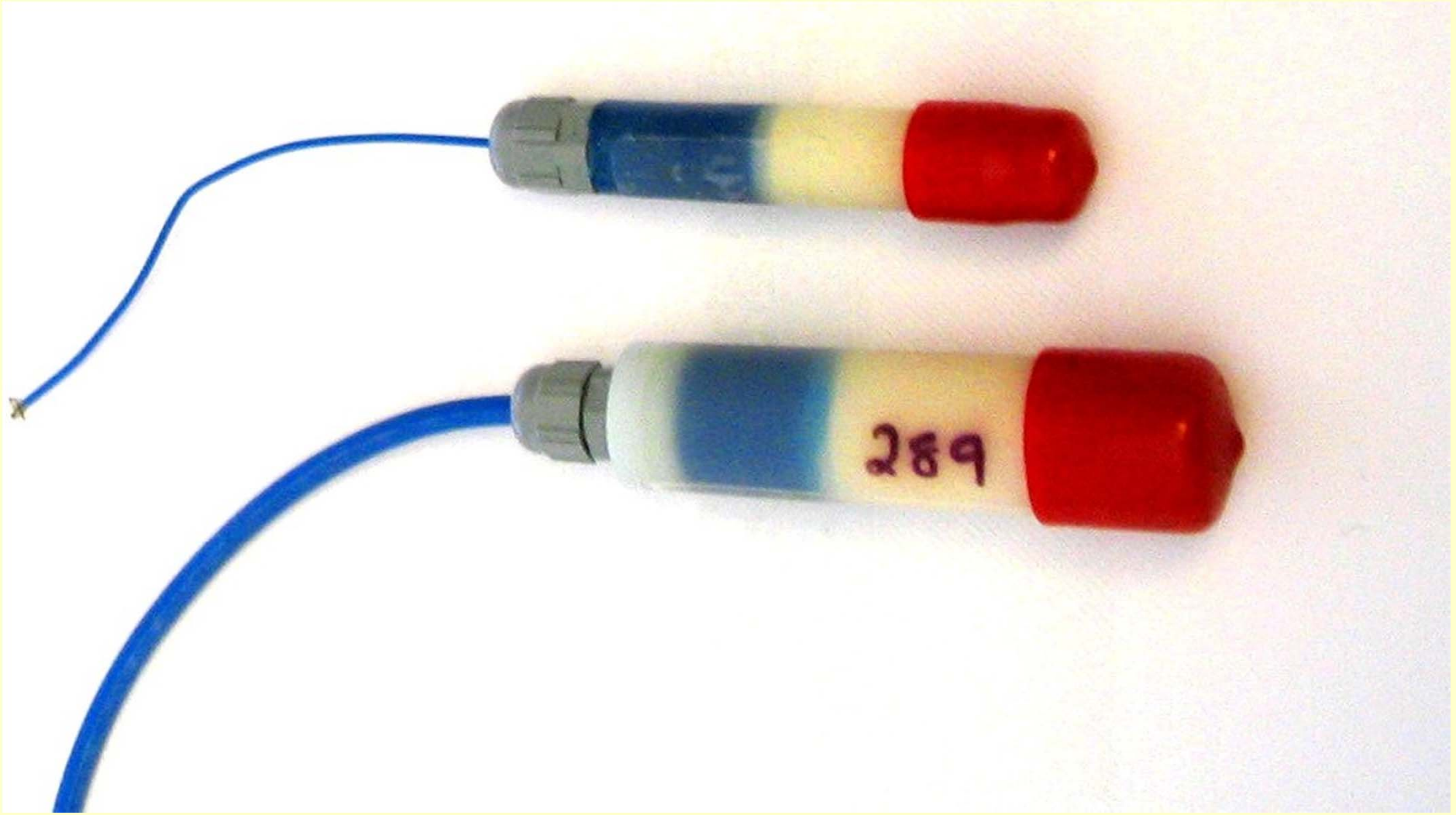


Exterior of Building





Failure to bond the discontinuous metal may result in either (i) cracking of the terra cotta modillion unit, or (ii) accelerated corrosion of the J hook support and potential spalling to ground level.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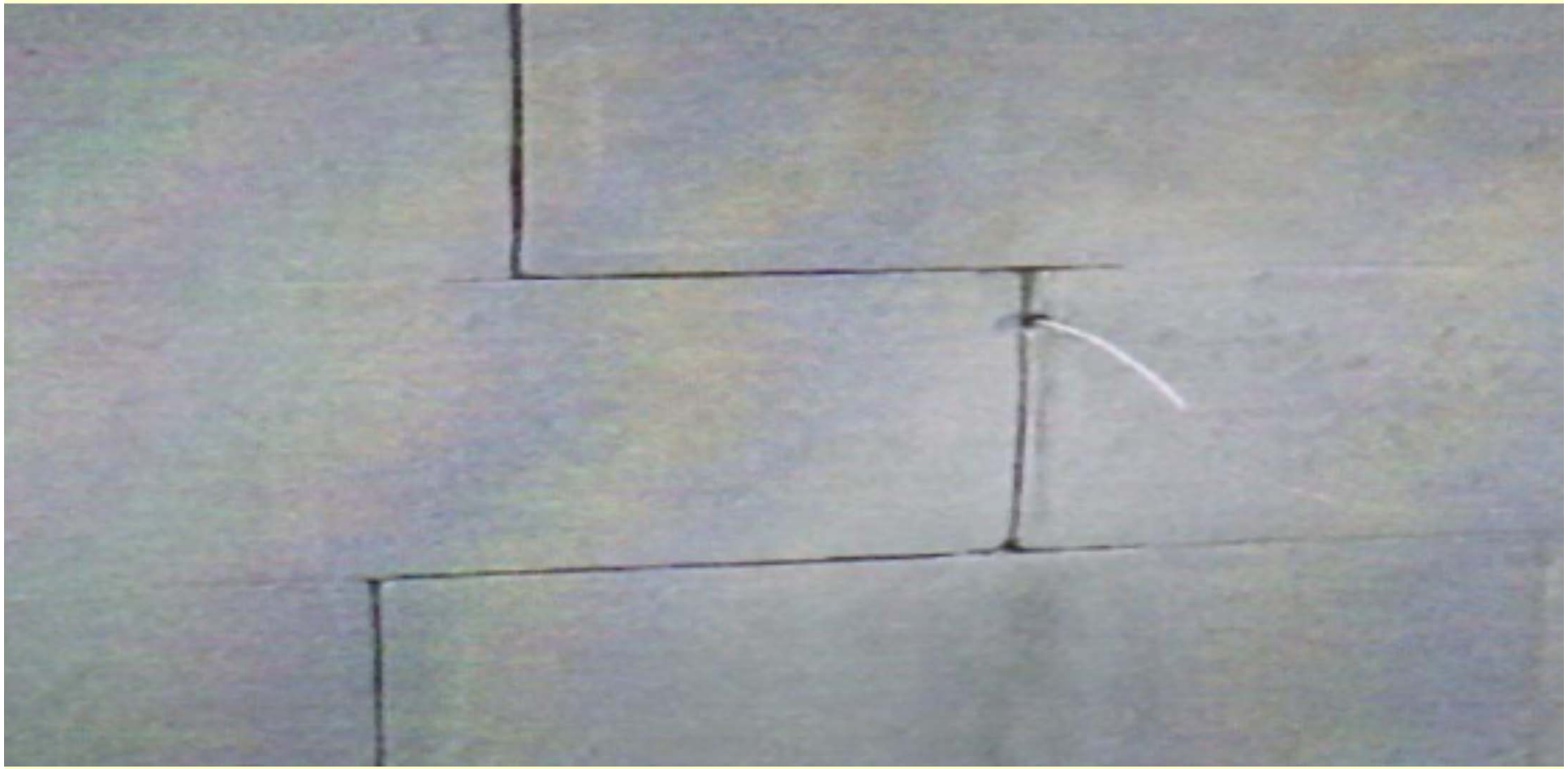
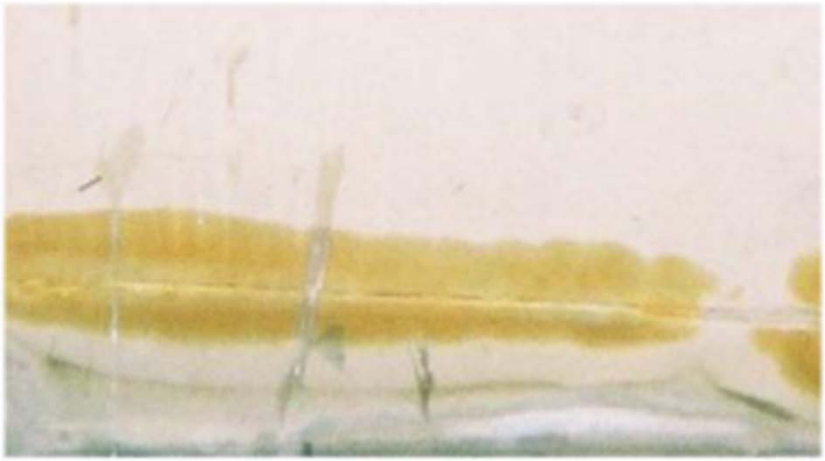
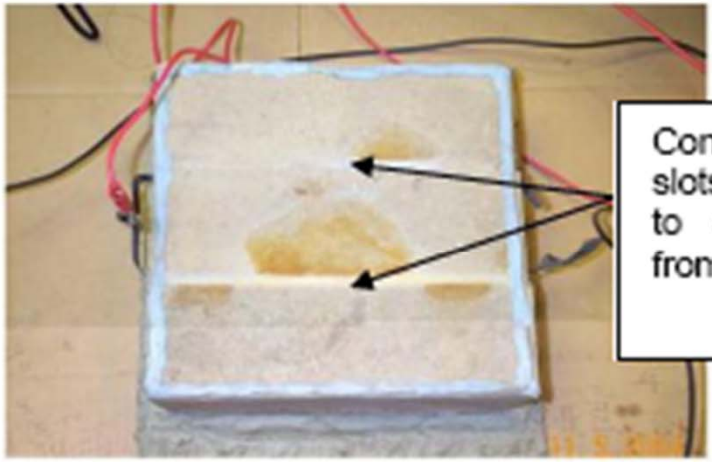


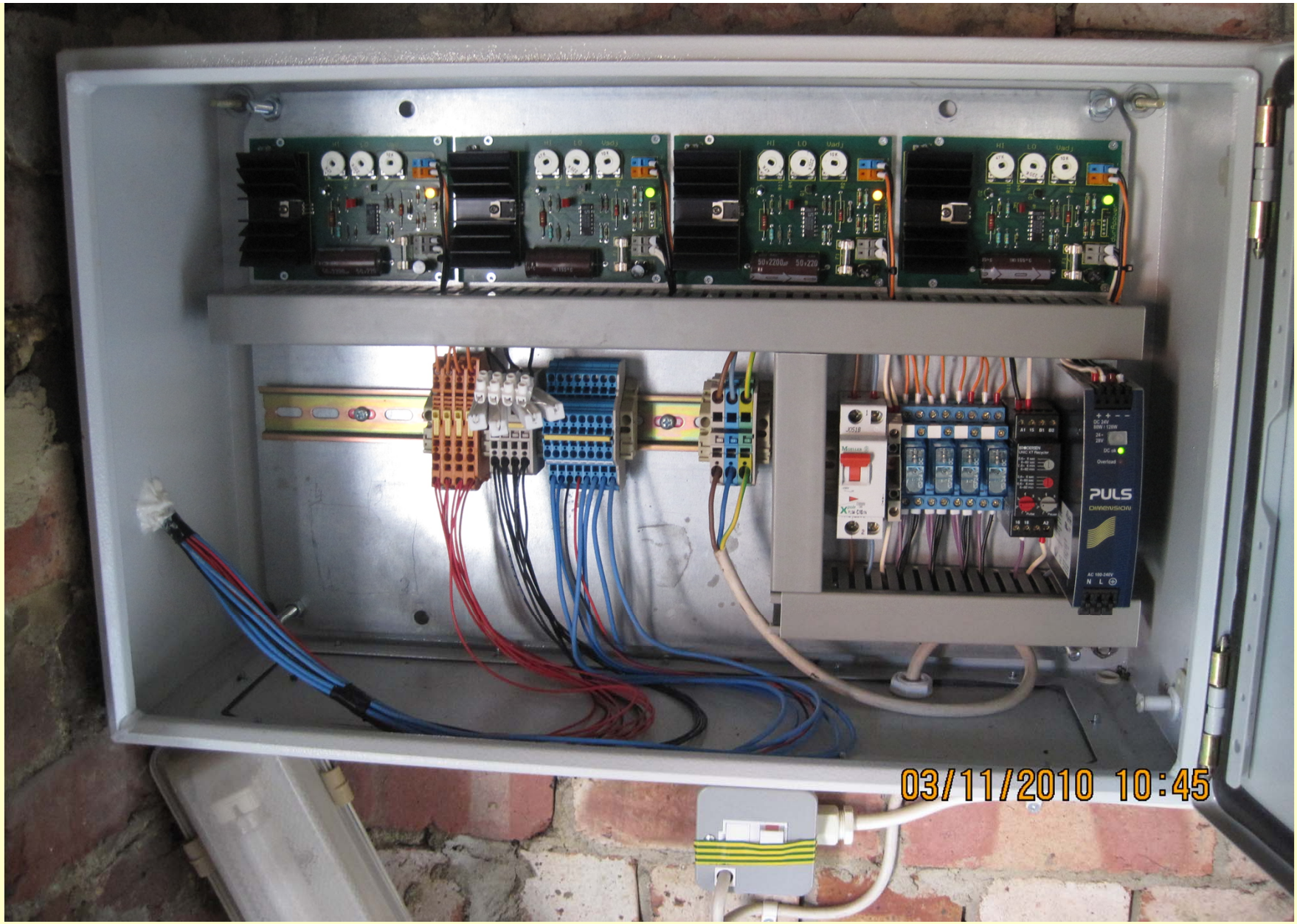




Contaminated ribbon slots. Iron filings used to simulate deposits from slot cutting tools.

St Martin's Lane
In Conservation Area


Zone 1
Zone 2
Z1R2
Z2R2
Z1R1
Z2R1
EPOCA
COFFEE
SERIOUS COFFEE SANDWICHES PASTA CAKES
C H I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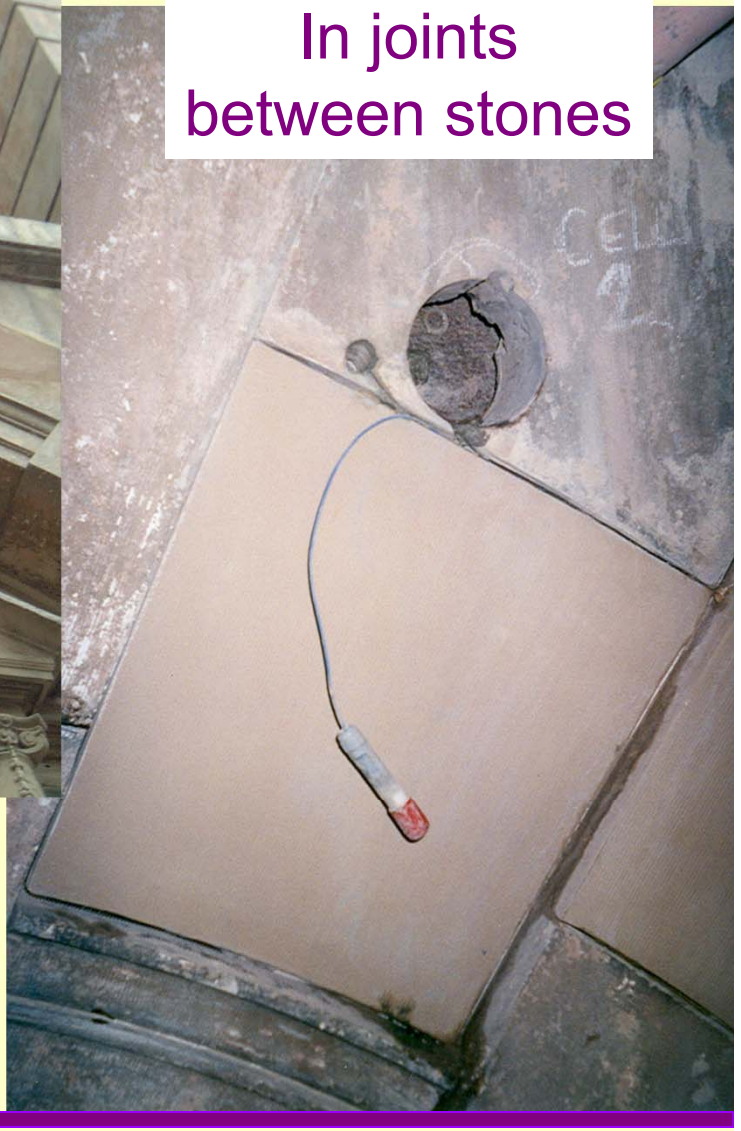
Ribbon Anodes In joints between stones



36 St Martin's Lane London
Originally part of the Coliseum next door – now flats above a coffee shop
Built 1904 Architect Frank Matcham

55-56 St Martin's Lane In Conservation Area

Conclusions I

- Each Historic Building is unique
- Each will require unique assessment and treatment
- Cathodic Protection can be
  - Less invasive
  - More reversible
  - Have lower visual impact
  - Very long life (>100 years)
  - Continual assurance of effectiveness
- 53 cases 1999-2008 listed in CPA Tech Note 20

Conclusions II

- If cathodic protection is the preferred solution
- Ensure there is adequate expertise in the design team
- Use an experienced contractor with qualified staff
- Undertake sufficient investigation to quantify the risks