

Concrete resistivity on small scale high performance concrete samples

Juan Lizarazo-Marriaga

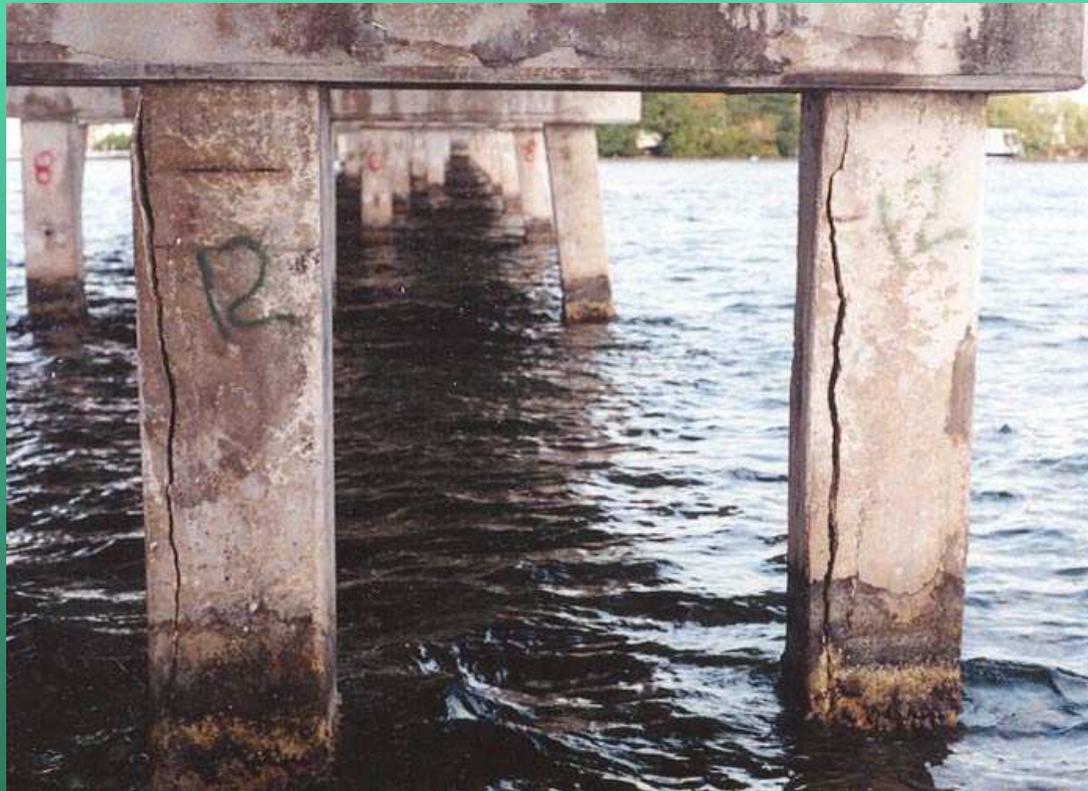
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Aix-en-Provence, France
May 29-June 1, 2012



Justification

- **Corrosion of steel reinforced concrete is caused by chloride ingress**
- **Widespread occurrence and high cost of repair.**





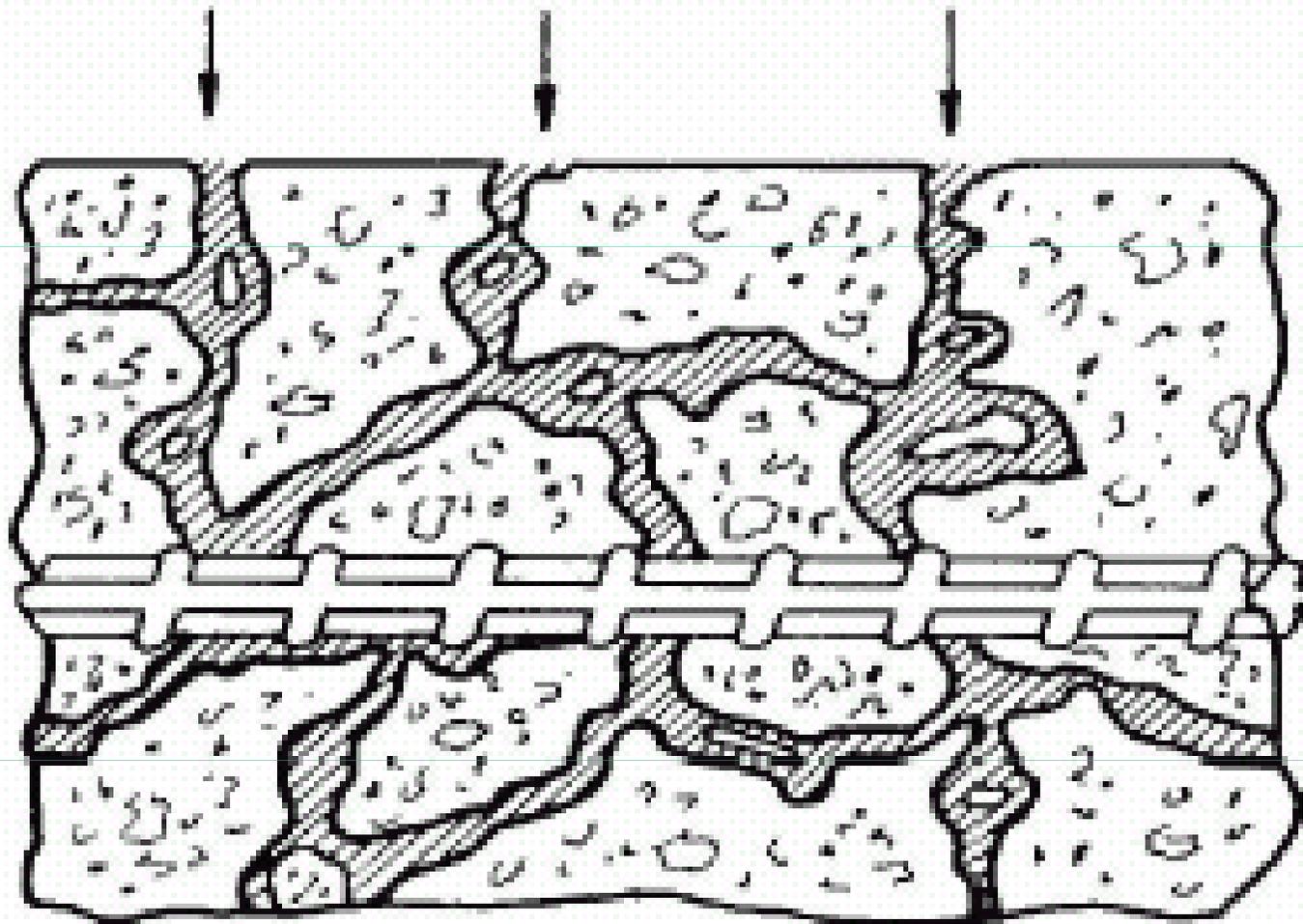
Corrosion Management

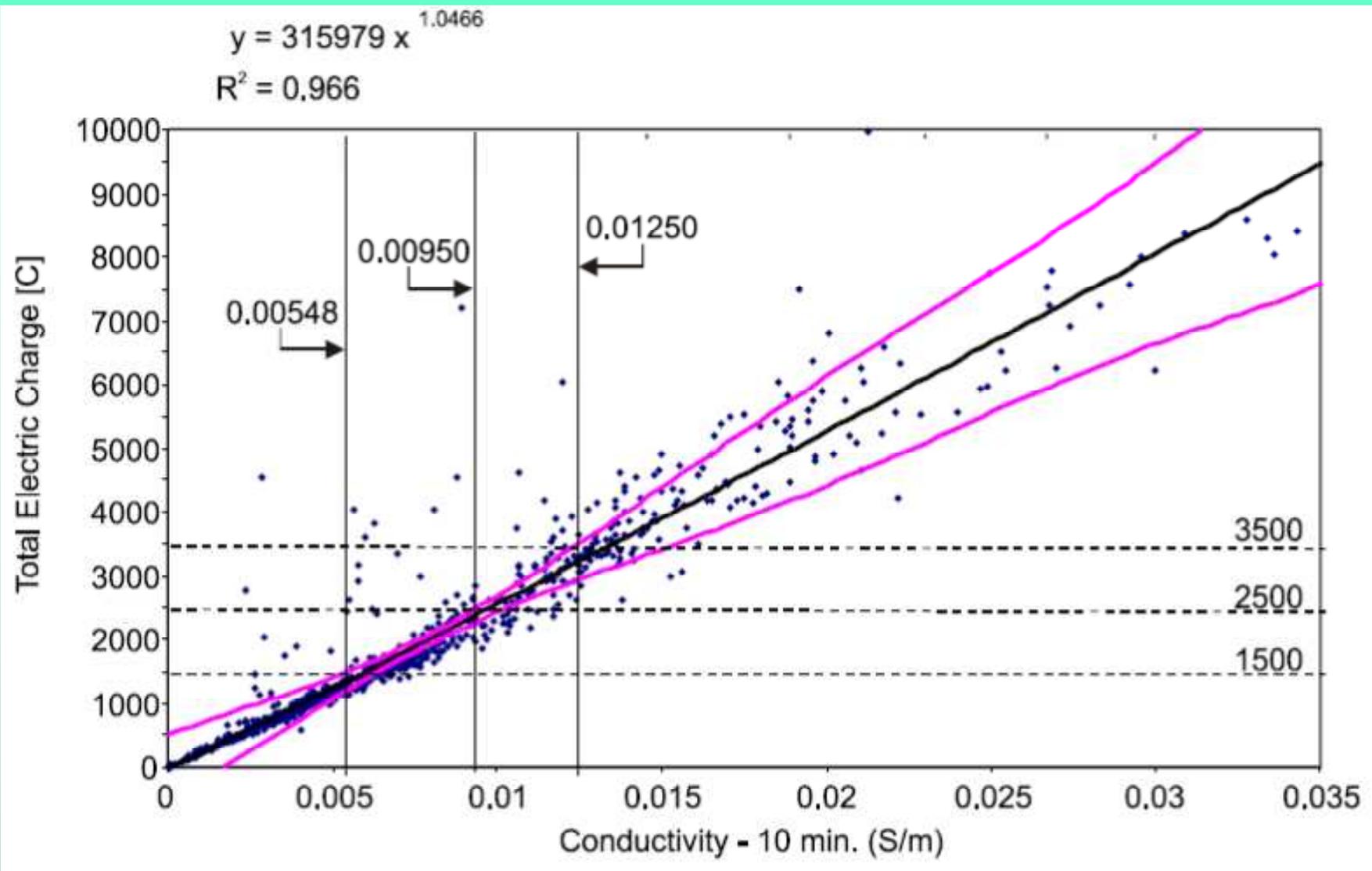
Selecting a corrosion mitigation strategy for existing concrete structures

According to a recently completed study by the U.S. Federal Highway Administration, the annual direct cost of steel corrosion to the U.S. economy is estimated at \$276 billion, or 3.1%, of the U.S. Gross Domestic Product (GDP).¹ If indirect costs such as loss of productivity are included, the annual cost is conservatively estimated at \$552 billion, or over 6% of GDP. While these statistics are specifically related to the overall cost of corrosion, some estimates indicate that up to 30% of this total is related to corrosion in concrete structures.



RED DE POROS





Relationship charge passed (RCPT) and electrical conductivity (Lane 2005)

NDT James RM-8000



Controls



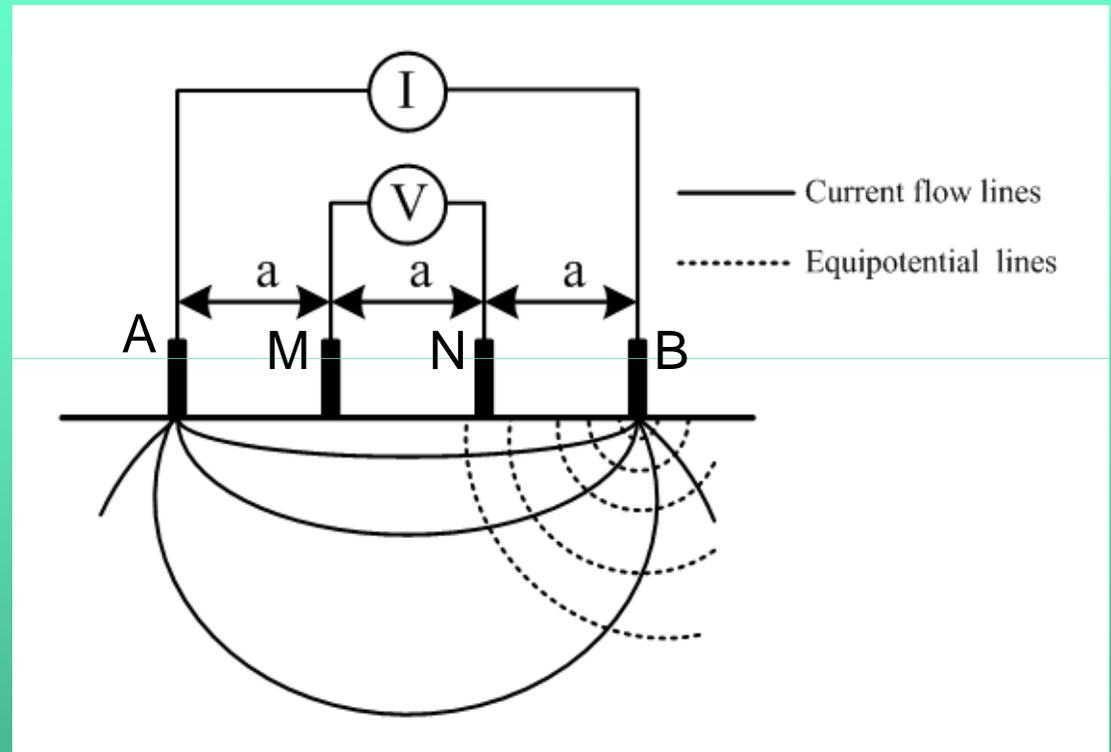
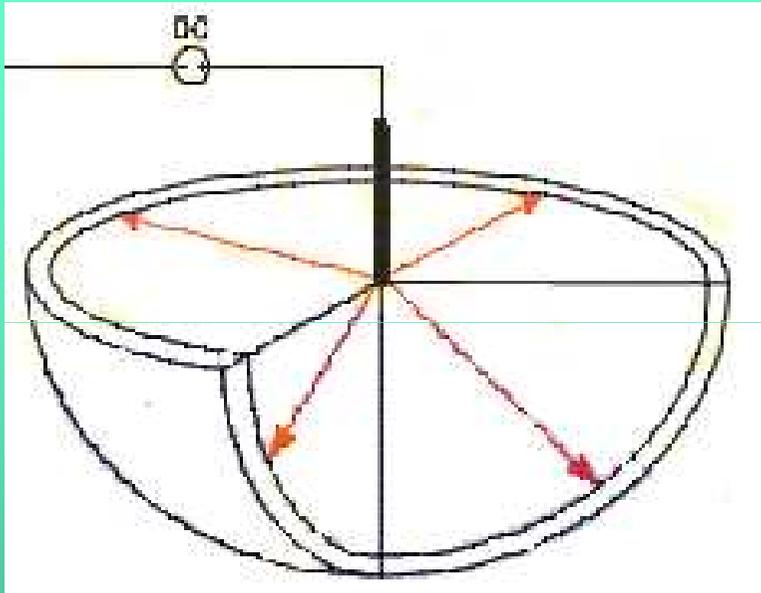
<http://www.proceq.com/en/non-destructive-test-equipment/concrete-testing/moisture-corrosion-analysis.html?gclid=CNyZ9vmapbACFU4lfAodrxCGXw>



Corvib RESI

SIMULATION OF THE CONCRETE CHLORIDE NT BUILD-492 MIGRATION TEST

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$$J = \sigma E = -\frac{1}{\rho} \frac{d\phi}{dr} = \frac{I}{2\pi r^2}$$

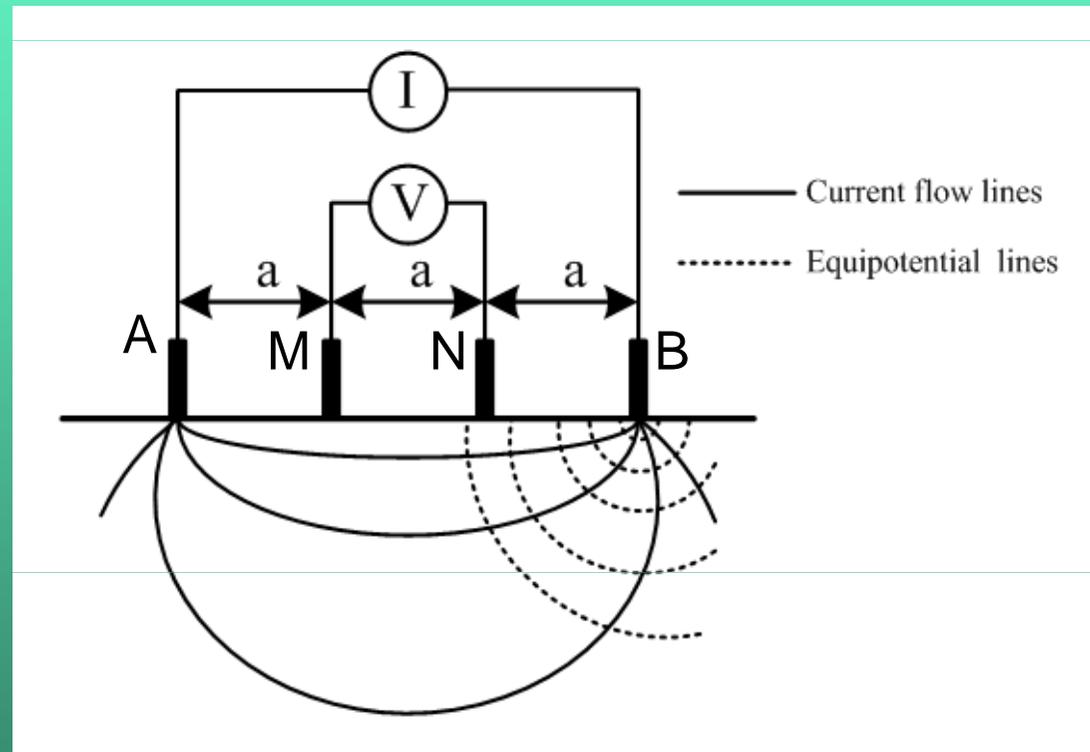
$$\phi(r) = \frac{\rho I}{2\pi r}$$

$$\phi_M = \frac{\rho I}{2\pi(a)} - \frac{\rho I}{2\pi(2a)}$$

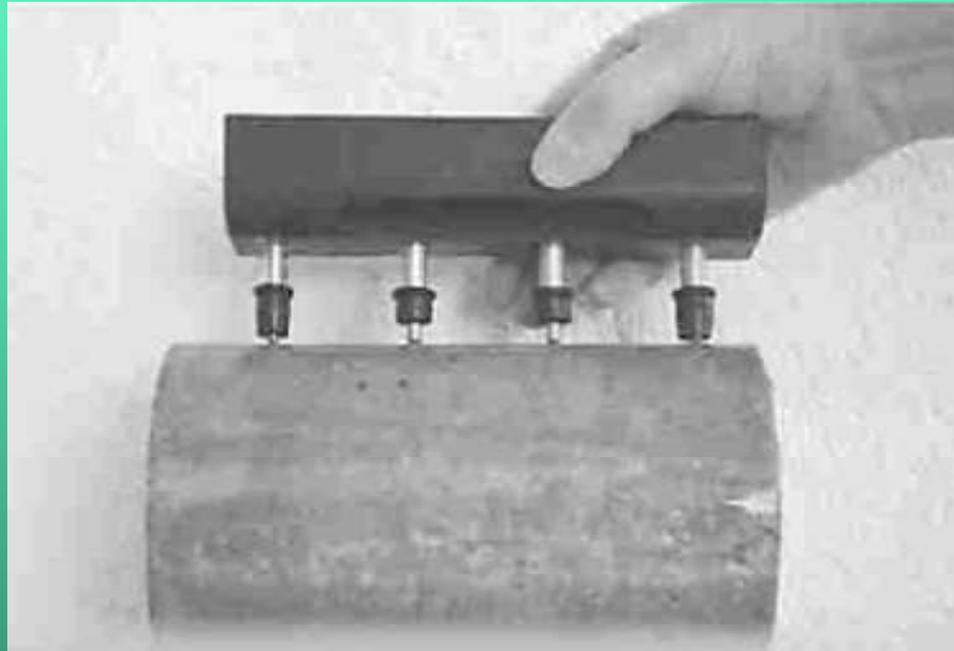
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$$\phi_{MN} = \frac{\rho I}{2\pi} \left[\left(\frac{1}{a} - \frac{1}{2a} \right) - \left(\frac{1}{2a} - \frac{1}{a} \right) \right] = \frac{\rho I}{2\pi a}$$

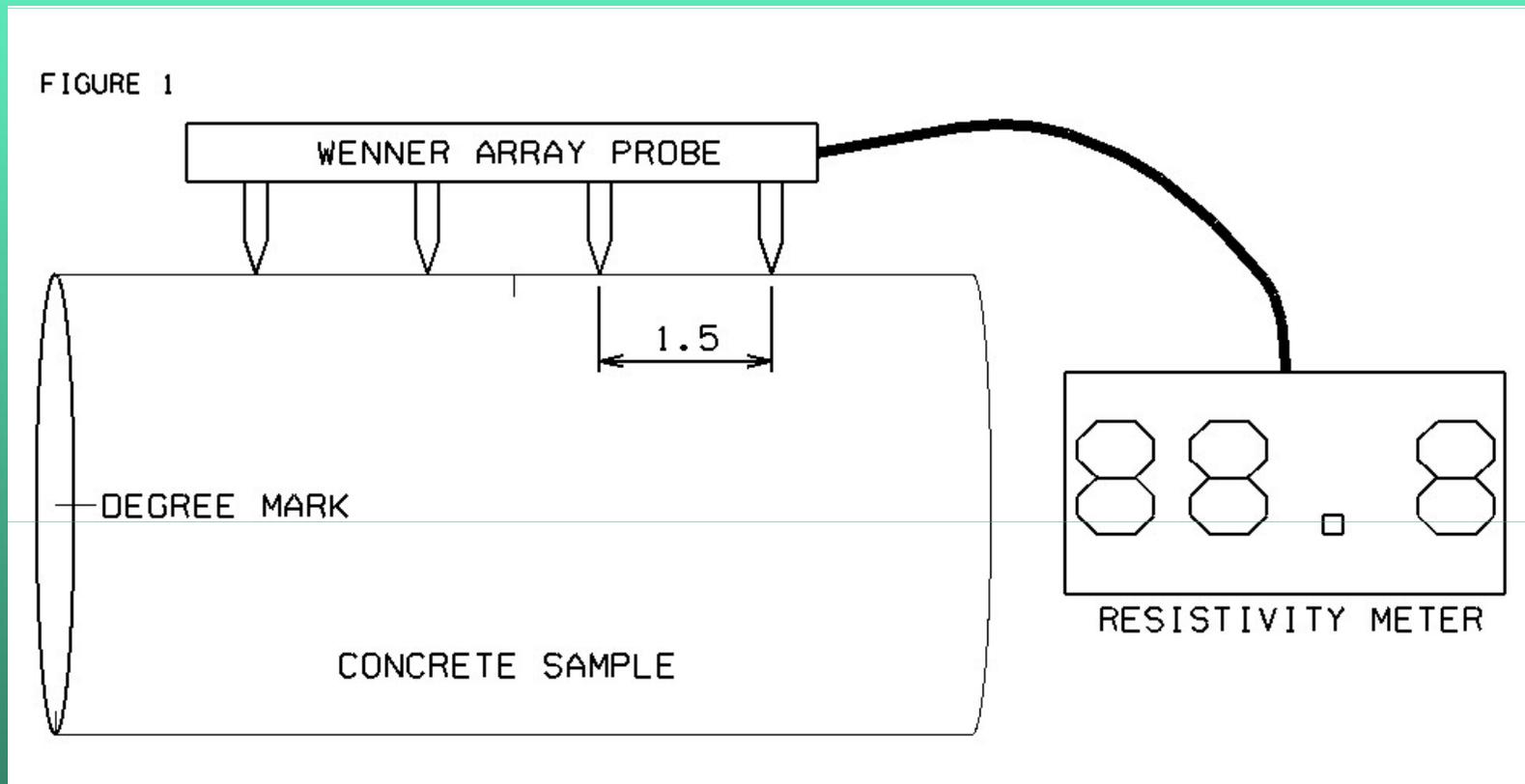


$$\rho = 2a\pi \frac{V}{I}$$

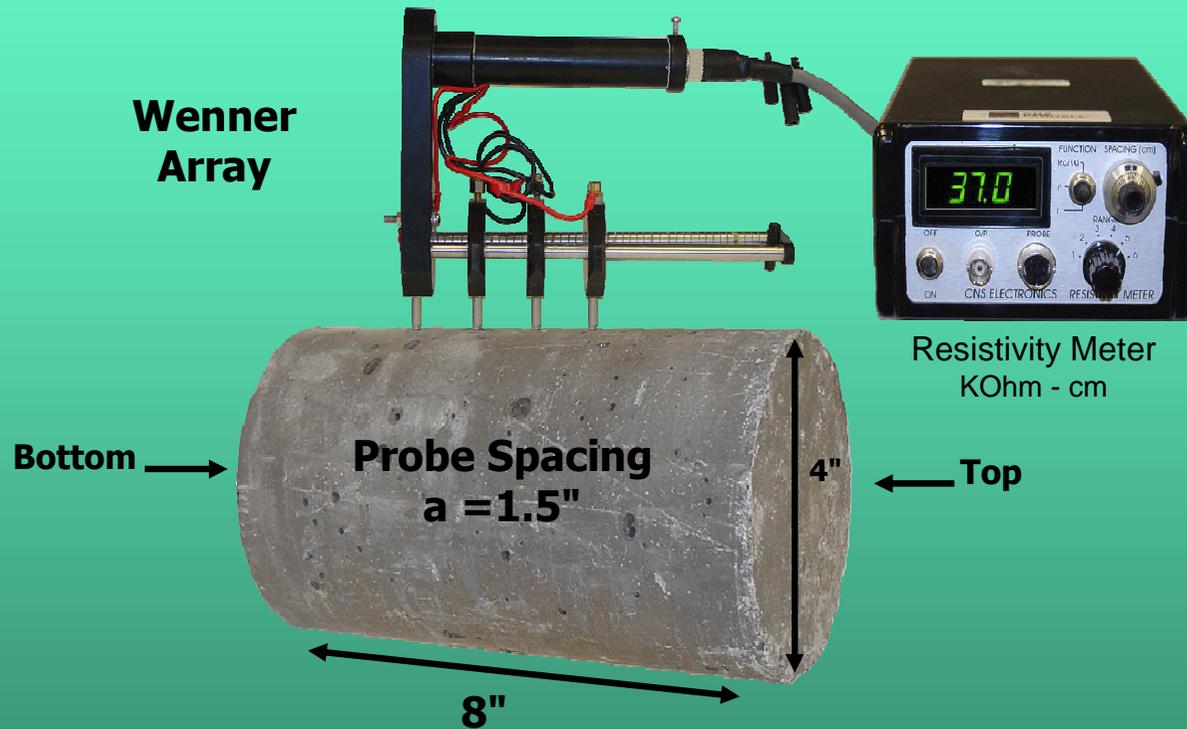


<http://www.concreteresistivity.com/RESIPOD%20-20OPERATING%20INSTRUCTIONS.pdf>

Florida Method of Test For Concrete Resistivity as an Electrical Indicator of its Permeability Designation: FM 5-578



AASHTO TP95-11, “Standard Method of Test for Surface Resistivity Indication of Concrete’s Ability to Resist Chloride Ion Penetration”

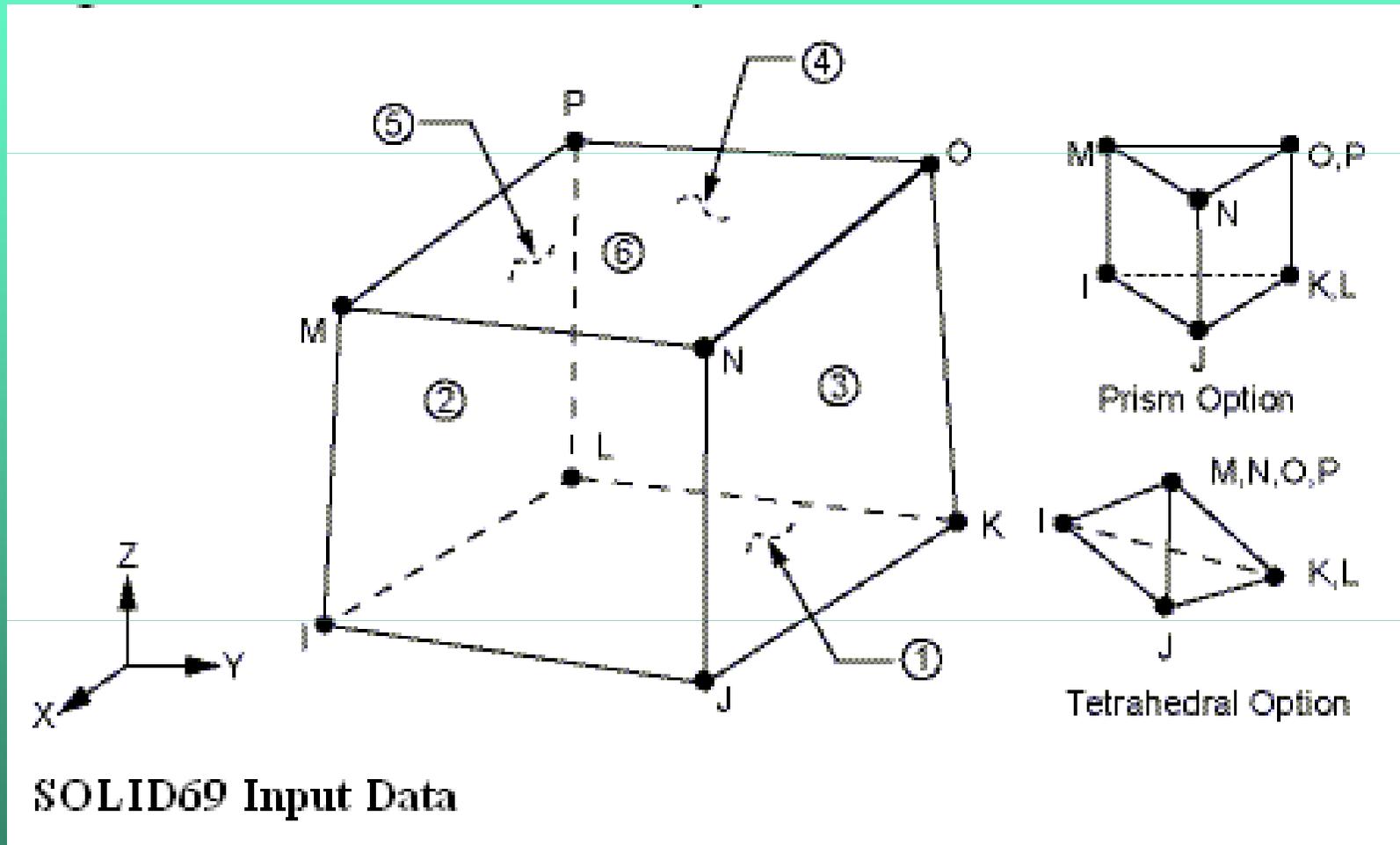


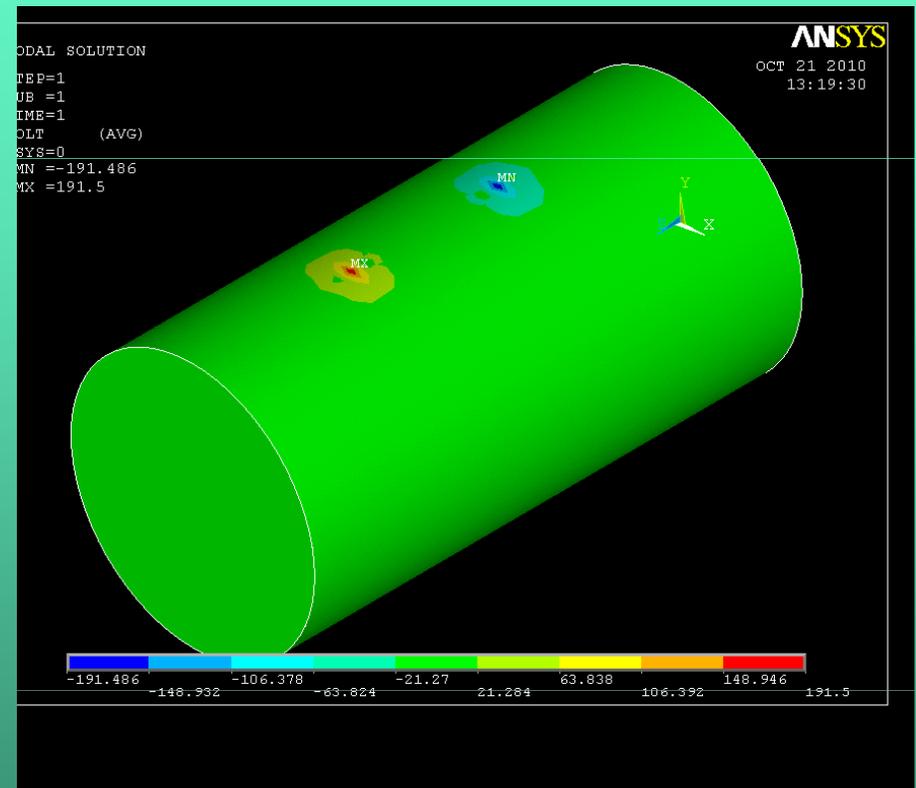
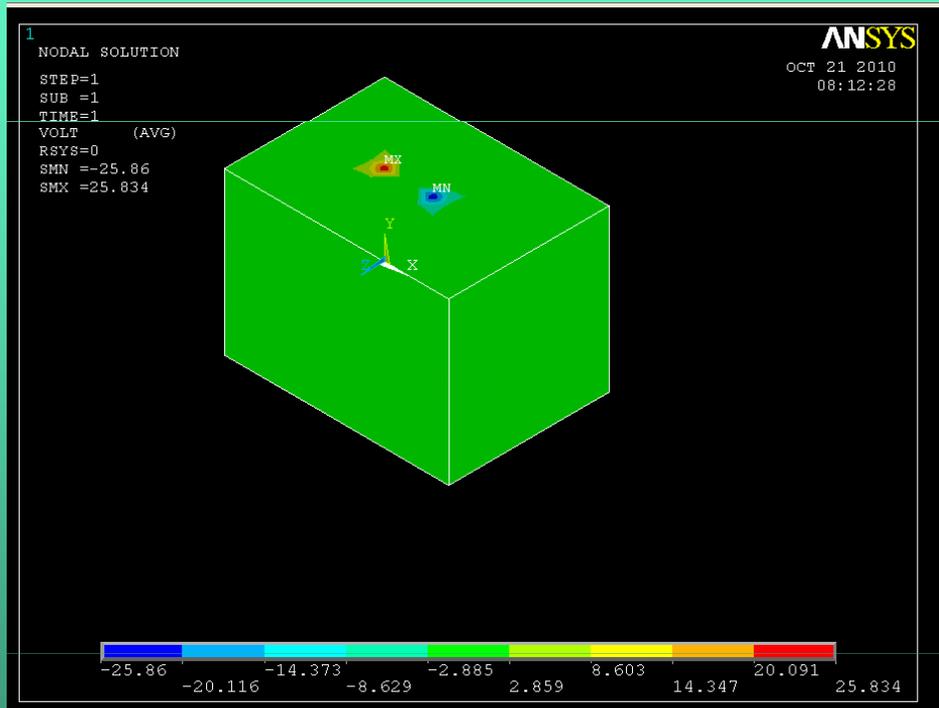
Precision Statements for the Surface Resistivity of Water Cured Concrete Cylinders in the Laboratory

By Mike Jackson for and Mario Paredes

SOLID69

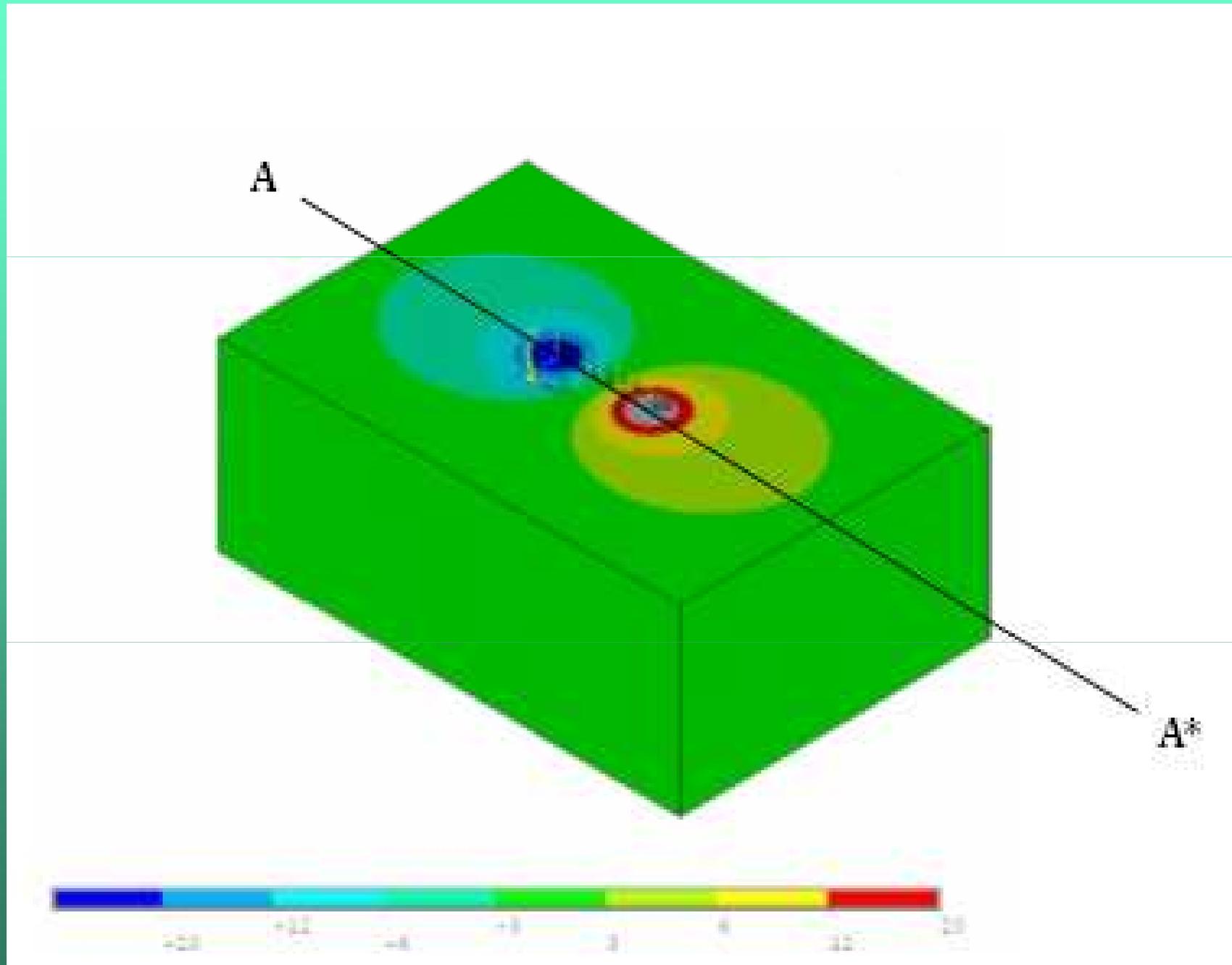
3-D Coupled Thermal-Electric Solid





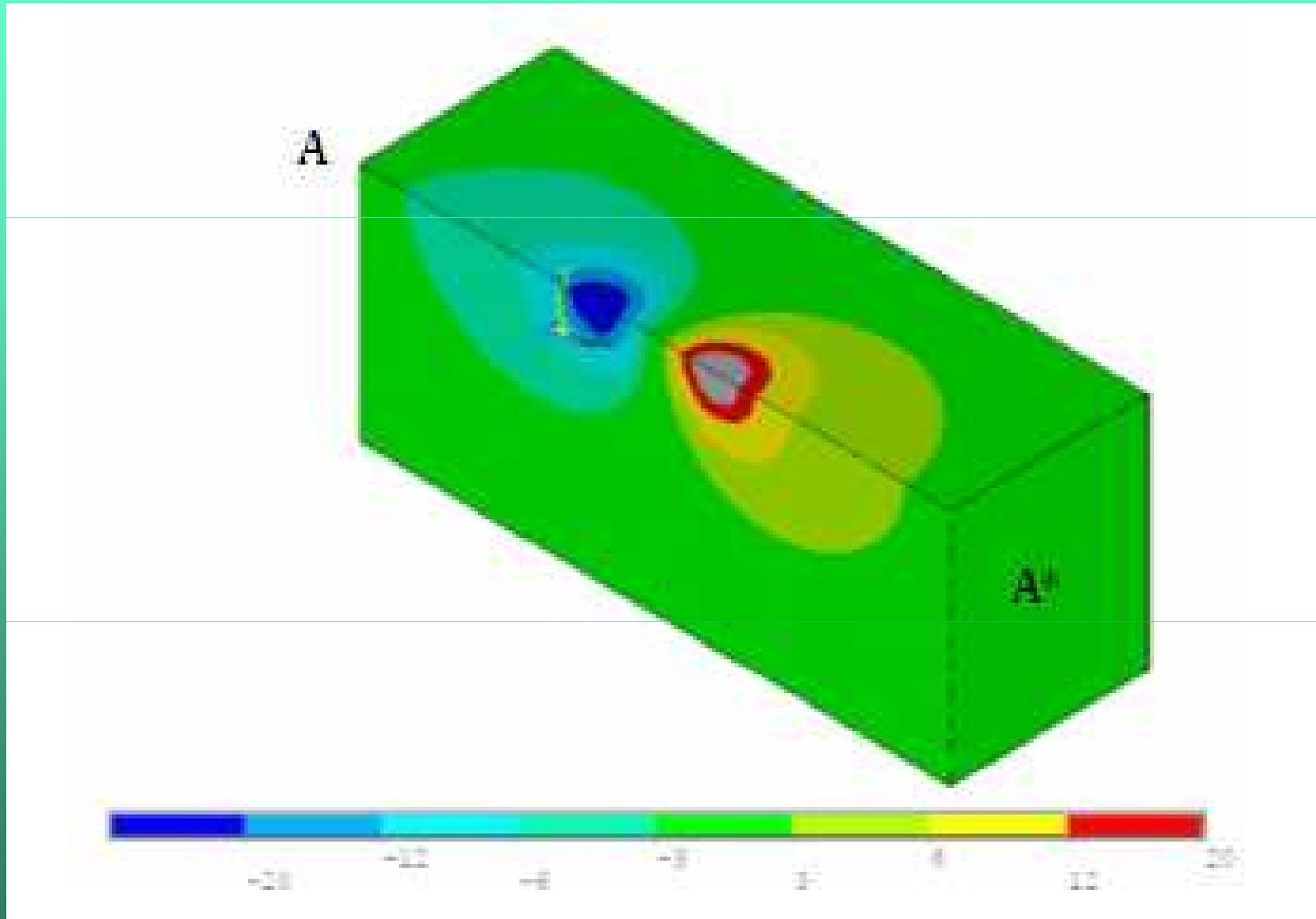
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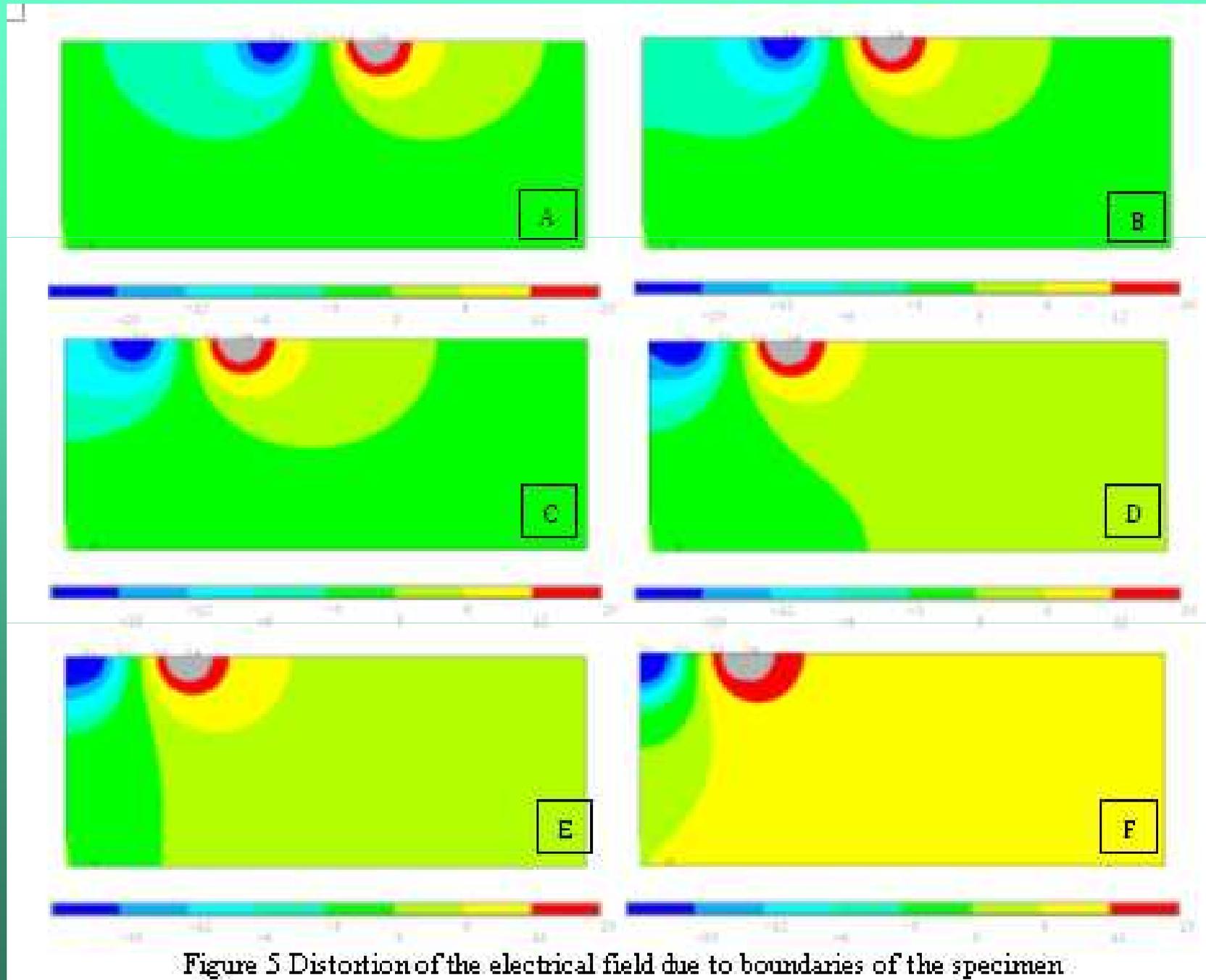


Figure 5 Distortion of the electrical field due to boundaries of the specimen

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Model	Edge distance [cm]	Edge distance / probe separation	Voltage measure d [V]	Measured resistivity ρ_o [ohm-cm]	Measured resistivity / theoretical resistivity [ρ_o/ρ_t]
A: S-infinite	12	6,0	15,90	19983	1,00
B	8	4,0	15,91	19998	1,00
C	4	2,0	16,07	20192	1,01
D	2	1,0	16,64	20908	1,05
E	1	0,5	18,76	23577	1,19
F	0	0,0	22,62	28424	1,42

Deviations of measured and theoretical resistivity because of the proximity to the edges

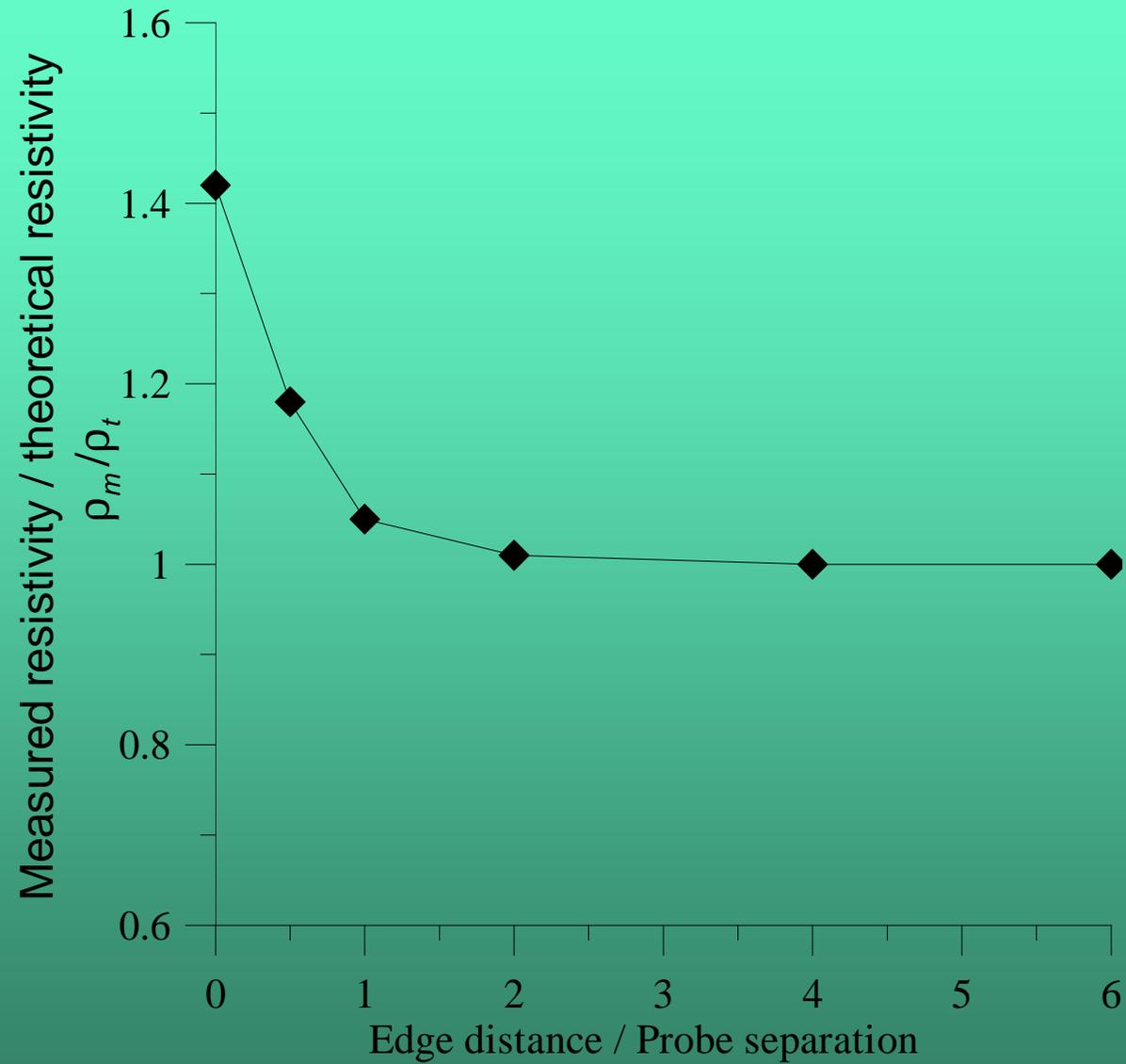


Figure 3. Resistivity deviations due to the ratio (Re/p)

Thanks