

# **First steps in the development of cement batteries to store PV energy to power cathodic protection of reinforcement in concrete structures**

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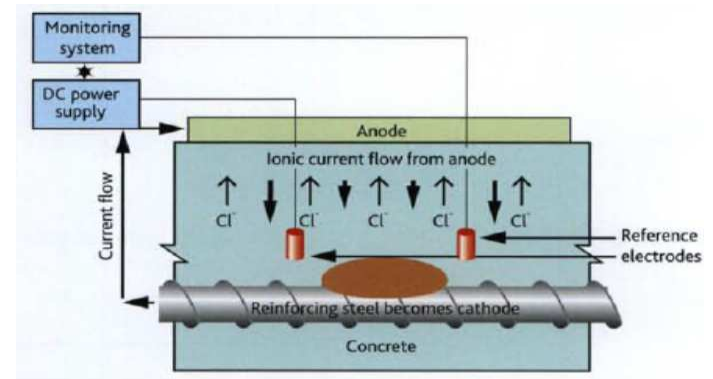
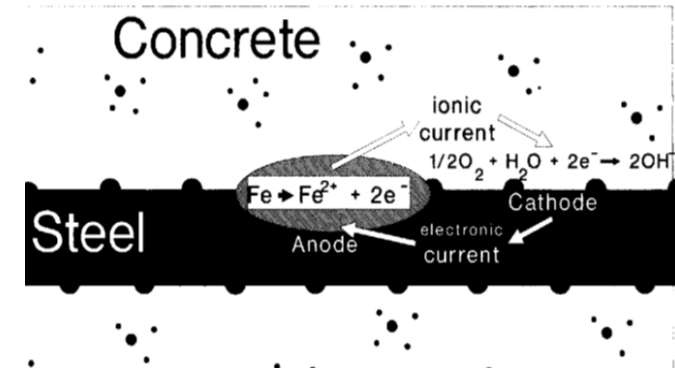
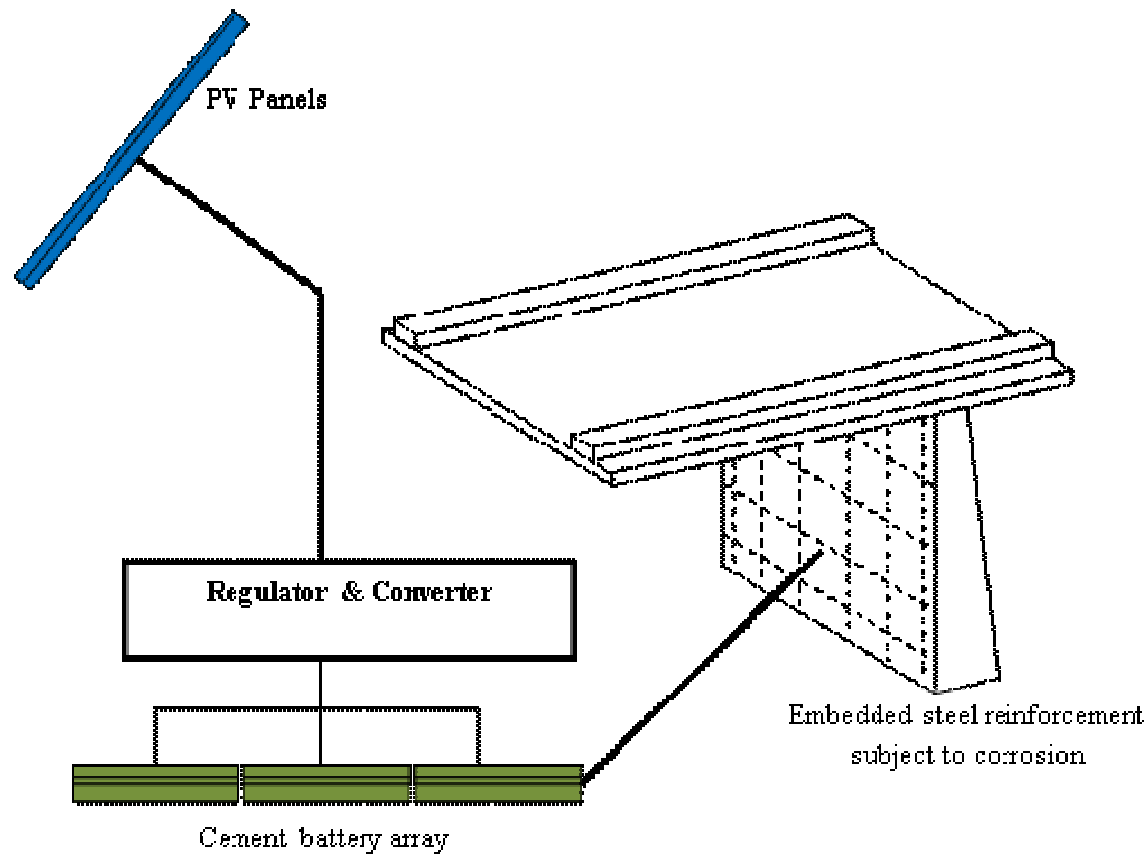


# Introduction

- The problem/motivation
  - Corrosion & cathodic protection
- Aim
  - Self sustaining solution using renewable energy and battery which can fit into the structure
- Funding

Enterprise Ireland TIDA

# Introduction



# Project Design/Methodology

s projects



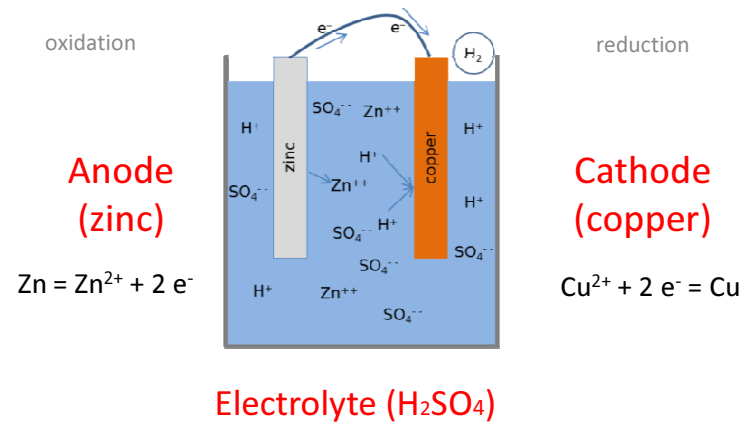


# Project Design/Methodology

Electrodes: electronic conductors

Electrolyte: ionic conductors

Good interfaces/connections

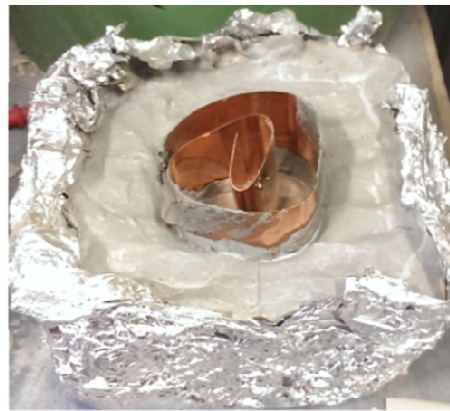


# Project Design/Methodology

- Two current masters projects
  - Slabs
  - Batteries
- **Future steps**
  - Ideal battery
  - Join up slabs to battery
  - Join PV cell to setup and compare with unprotected
  - Upscale and test on real system



# Findings



# Findings

- Electrode materials

Magnesium highest in V,I  
and Lifespan



Anode material:	Magnesium	Aluminium	Zinc
Voltage (V)	1.553	1.417	0.059
Current (A)	23	1.92	0.1
Lifespan (hrs)	36	8	2min



# Findings

No discernible pattern  
(but did observe current stored  
in plates greater for larger Al)

- Ratios of electrodes to each other



Cu	1	1	2	1	3	1	4
Al	1	2	1	3	1	4	1
Voltage (V)	1.206	1.208	1.202	1.209	1.286	1.205	1.206
Current (A)	1.04	1.042	1.4	1.6	1.49	1.06	1.079
Lifespan (hrs)	6	6	6	6	6	6	6



# Findings

- Water/cement ratios

Higher water content ->  
higher V and I



w/c	0.3	0.4	0.5	0.7
Voltage (V)	1.183	1.268	1.26	1.271
Current (A)	1.14	1.18	1.2	1.26
Lifespan (hrs)	6	6	6	6

# Findings

No discernible pattern

- Distance between electrodes



Distance	5cm	10cm	30cm	60cm	80cm
Voltage (V)	1.289	1.322	1.317	1.38	1.317
Current (A)	1.74	1.56	1.32	1.64	1.13
Lifespan (hrs)	7	7	7	7	7

# Findings

No discernible pattern

- Aggregate in the electrolyte



Mix	Water, cement	Water, cement, sand	Water, cement, aggregate
Voltage (V)	1.208	1.301	1.292
Current (A)	1.18	1.19	1.2
Lifetime (hrs)	6	6	6

# Findings

Increases V, I and lifespan

- Carbon black



Water, cement, water reducing agent	0	Carbon black
Voltage (V)	1.242	1.401
Current (A)	1.26	1.82
Lifetime (hrs)	6	8

# Findings

Increases longevity

- Replacing water with salt solutions



solution	water	0.5M sodium chloride	0.5M Potassium Aluminium Sulphate (Alum salt)	0.5M Magnesium Sulphate (Epsom salt)
Voltage (V)	1.401	1.493	1.343	1.296
Current (A)	1.82	1.43	1.38	1.56
Lifetime (hrs)	8	12	12	12

# Findings

Increases I and longevity,  
Decreases V

- Adding salt in crystal form (instead of solution)



solution	water	Potassium Aluminium Sulphate (Alum salt)	Magnesium Sulphate (Epsom salt)
Voltage (V)	1.401	1.346	1.296
Current (A)	1.82	2.1	2.1
Lifetime (hrs)	8	13	13



# Findings

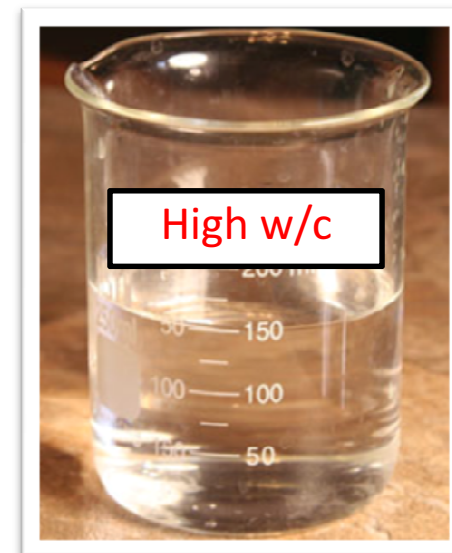
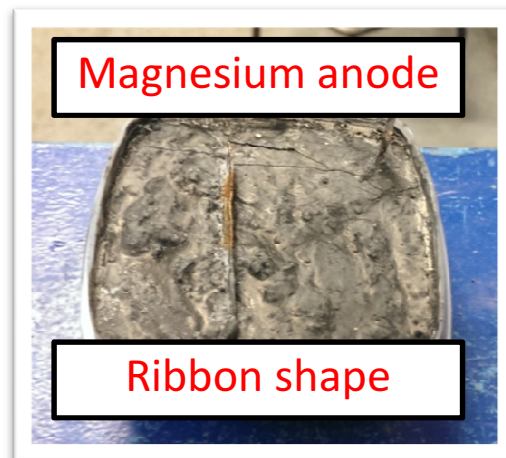
Worse  
(but did see improvement in contact  
between electrodes and electrolyte)

- Adding sodium silicate in different forms



solution	water	Sodium silicate solution	Coat plates in sodium silicate	Sodium silicate solution and water
Voltage (V)	1.401	0.43	1.356	1.38
Current (A)	1.82	0	1.48	1.7
Lifetime (hrs)	8	15sec	7	7

# Findings

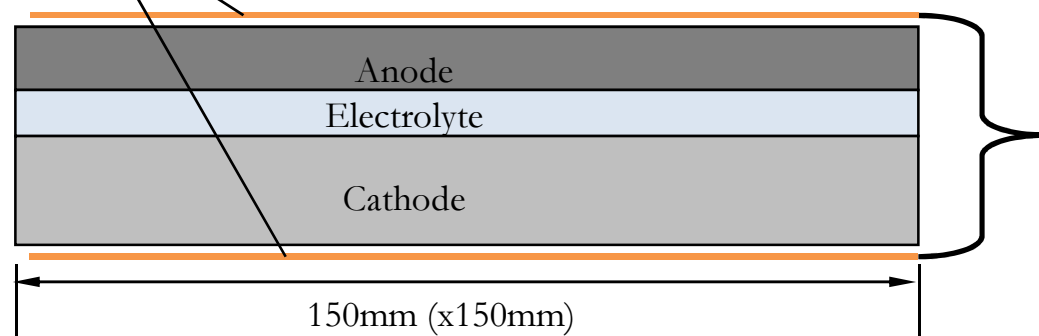


# Current work

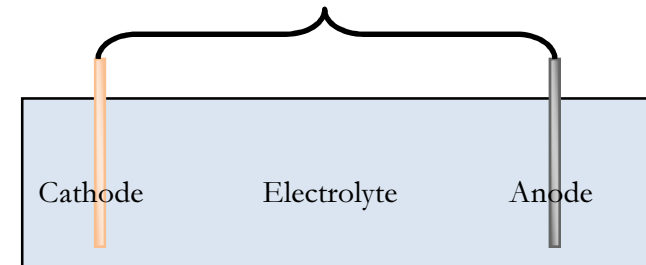
- Layered batteries



Electrical  
contacts



Electrical output



Electrical output

V	0.443 v
I	0.002 mA

# Improvements (next steps)

- Look into particle shapes and sizes
- Purity
- Removing oxide layers
- Sealing
- Electrical connections (ideally silver paint)
- layer thicknesses
- Additives/solutions (overall and per layer)
- More precise multimeter
- Continuous recording on LabView

**Thanks!**

Questions/ comments /suggestions?

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