CORROSION DETECTION

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WHAT IS CORROSION?

Surface corrosion – ugly but not yet structurally dangerous

http://www.european-coatings.com/var/ezflow_site/storage/images/european-coatings/home/raw-materials-technologies/applications/protective-marine/corrosion-behaviour-analysed/504626-1-eng-GB/Corrosion-behaviour-analysed.jpg

WHAT IS CORROSION?

http://www.daviddarling.info/images/pipeline_corrosion.jpg

Surface corrosion – ugly but not yet structurally dangerous

More serious corrosion – function is impaired

WHAT IS CORROSION?

http://www.monkeywrenchps.co.uk/wp-content/uploads/2012/08/Corrosion_Steel1.jpeg

More serious corrosion – function is impaired

Corrosion can occur in one place

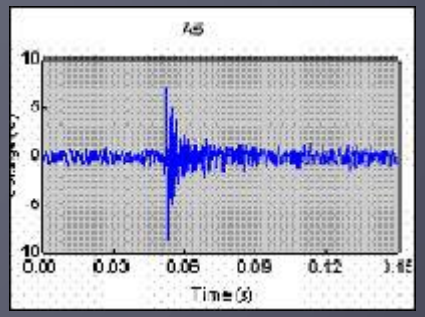
WHAT IS CORROSION?

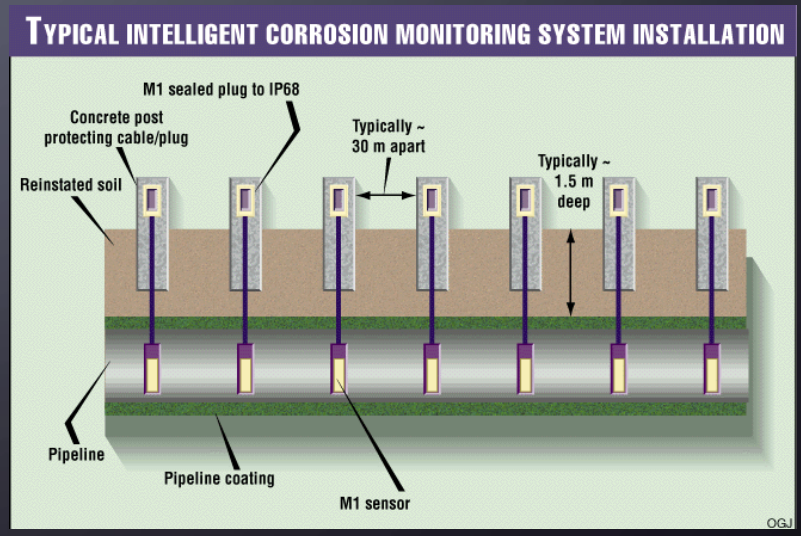
Corrosion can occur in one place

Corrosion can occur catastrophically

EXISTING CORROSION DETECTION METHODS

- Forth Road Bridge near Edinburgh used microphones to sense when corroded steel cables snapped – this led to the decision to create the Queensferry crossing
- Florida authorities are using SAW technology to monitor corrosion in steel reinforced concrete bridges
- Ultrasonics and acoustics are used extensively but require embedding or acoustic impedance matching





PROJECT SCOPE

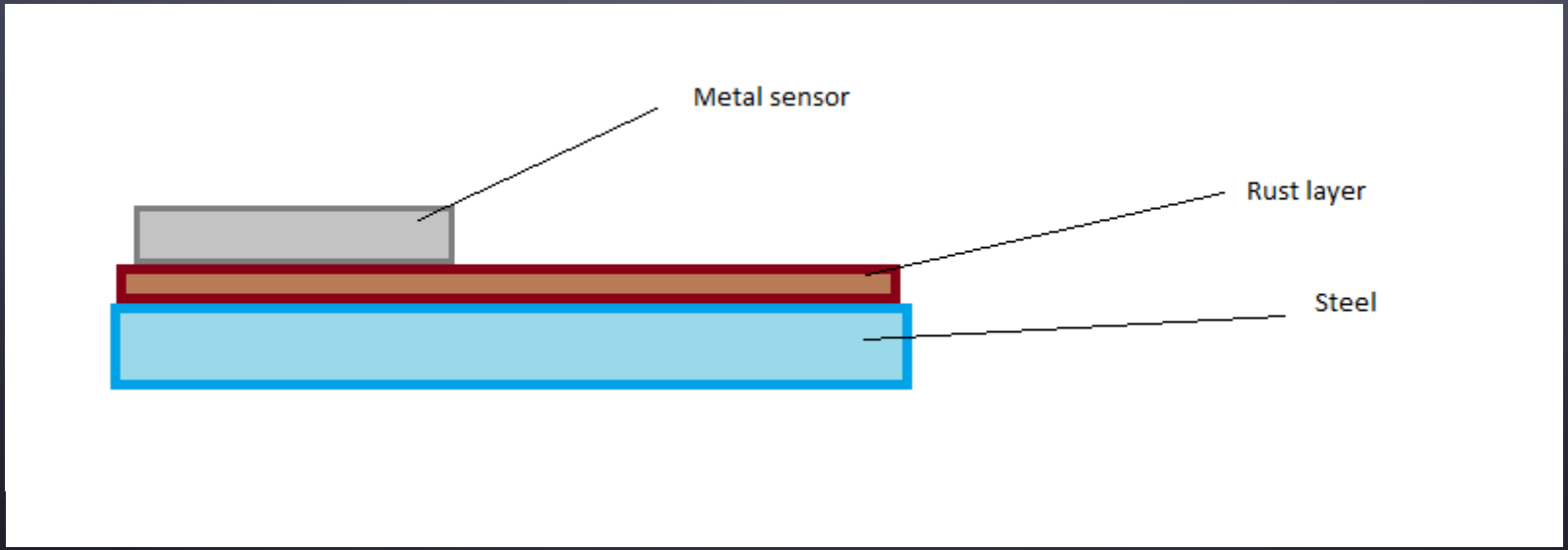
- Decided to limit to steel corrosion (rust)
- Decided to investigate corrosion sensing electronically
- How is rust different to metal?

HOW IS RUST DIFFERENT TO METAL?

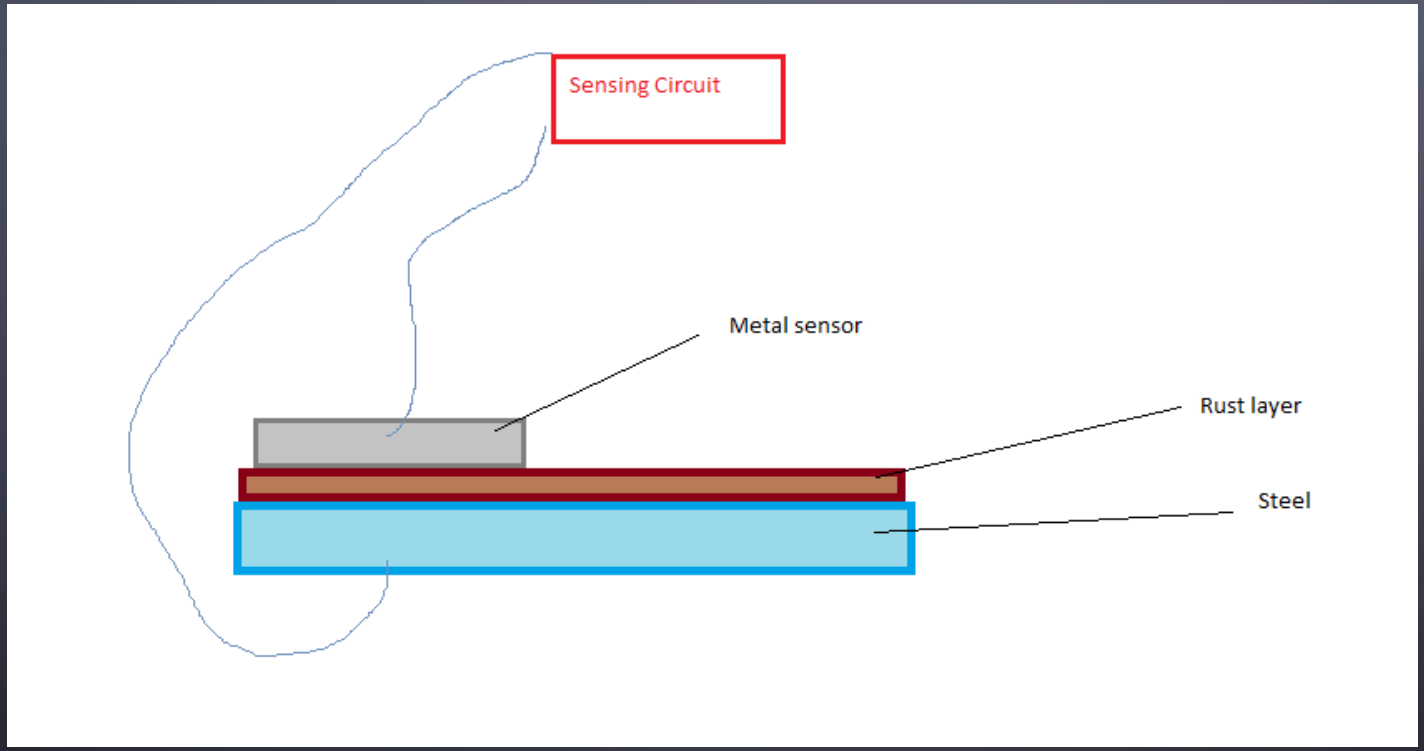
- No longer rigid
- No longer crystalline
- Visually different
- Rough
- Flaky
- Non-conductive

NON-CONDUCTIVE

- When a layer of rust is present, with steel underneath, a metallic sensor in contact with the rust would make an electric capacitor

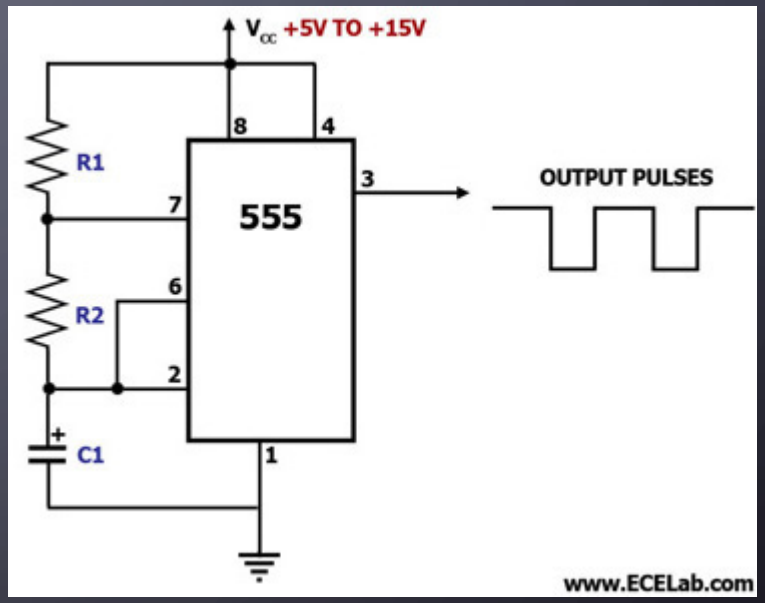


SENSING RUST

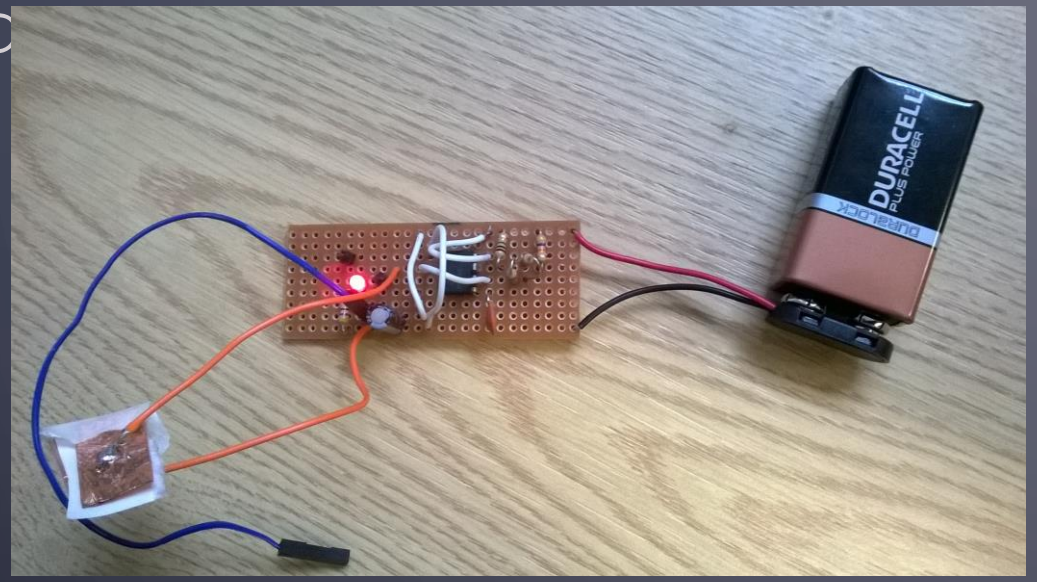


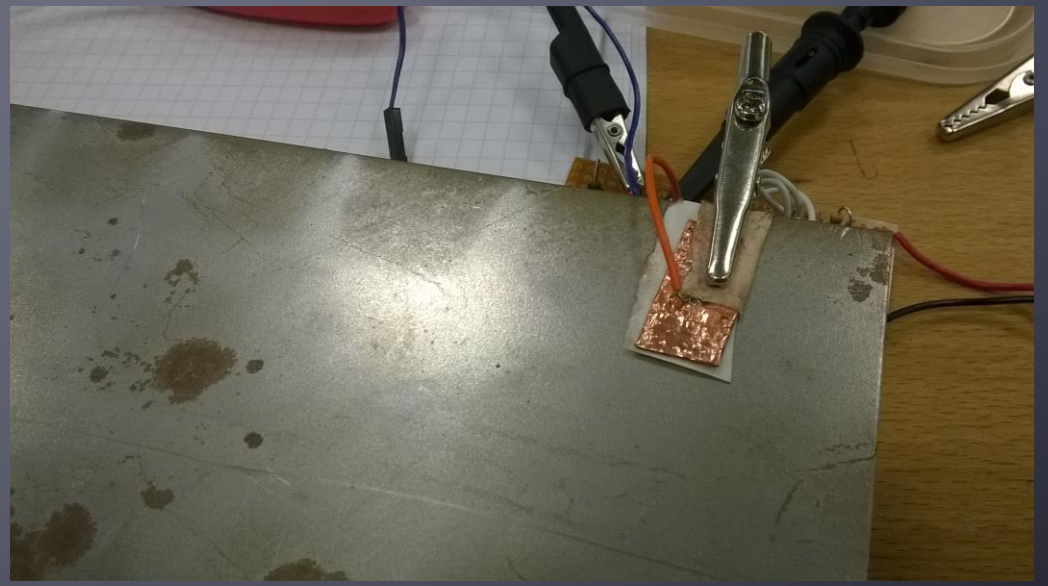
CIRCUIT TO DETECT CHANGE IN CAPACITANCE

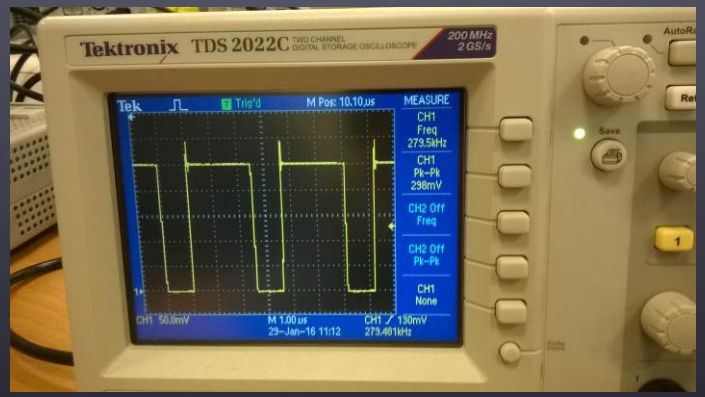
- 555 timer circuit
- Gives a signal out that changes frequency based on chosen capacitor value
- Would give different signal if rust were present or absent



555 TIMER CIRCUIT OUTPUT

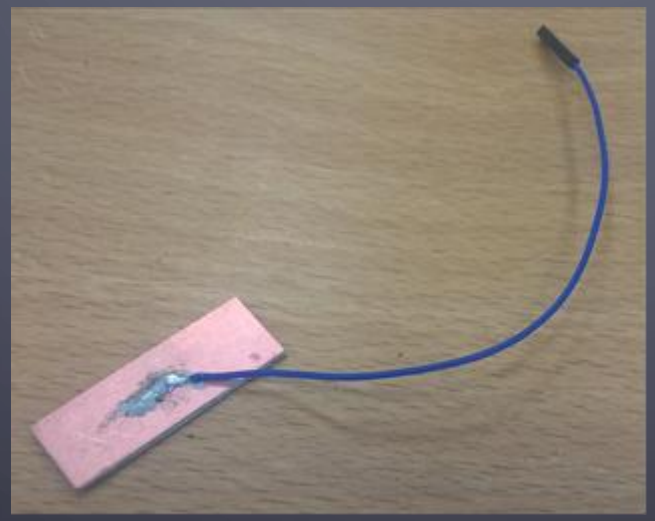


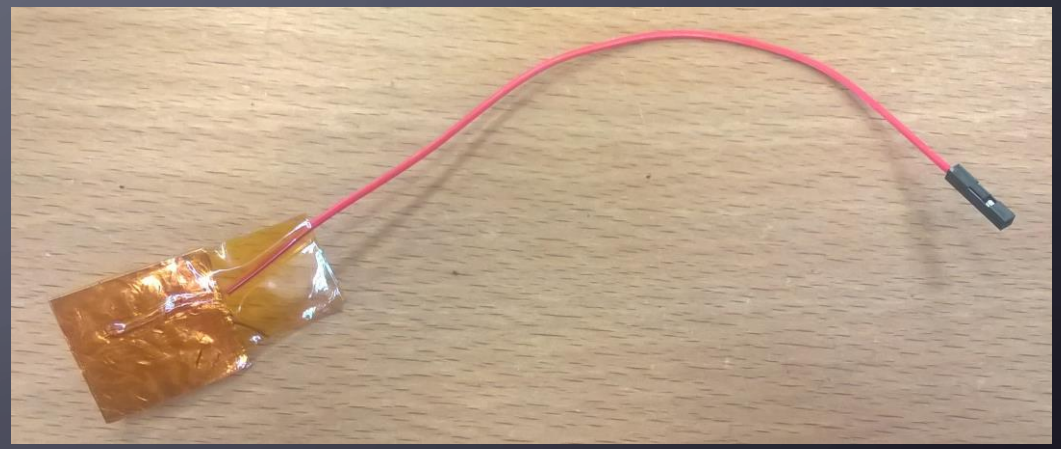




DIFFERENT SENSORS

- Tried different sensor ideas, both with and without their own layer of dielectric.





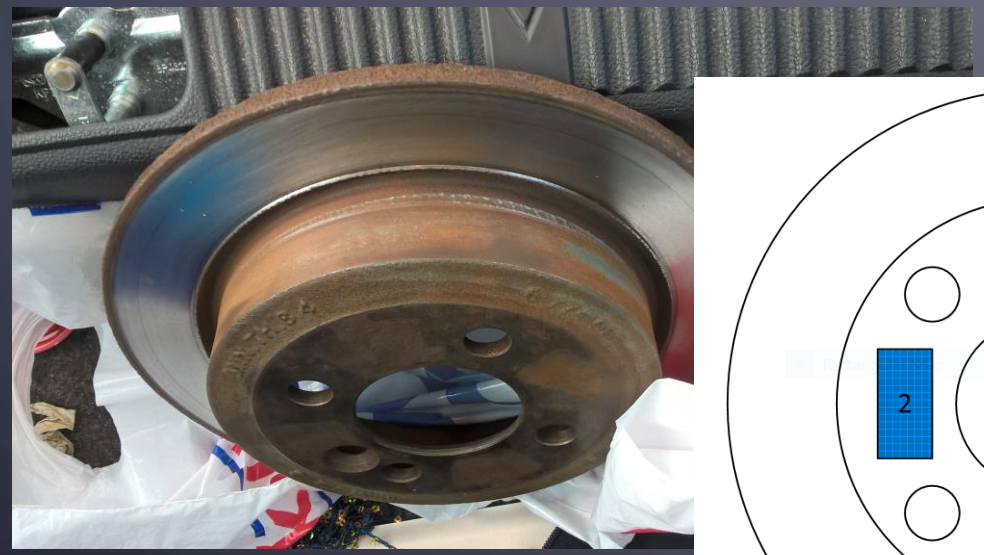
PROBLEMS!

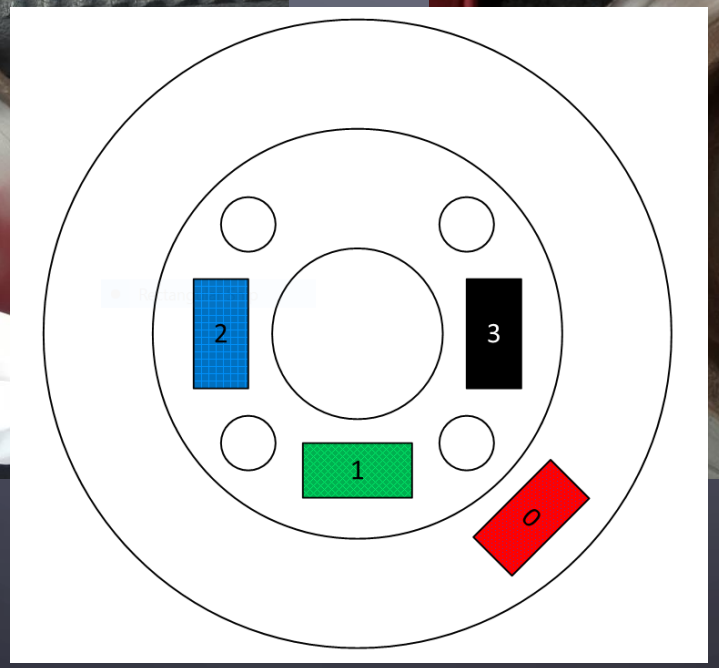
- If the sensor had its own dielectric, there was no difference in output signal observed when the sensor was placed on rust vs. a rust-free surface
- The signal varied widely due to pressure on the sensor, and this variation was much greater than the natural variation due to noise
- The sensor wire connecting back to the circuit appeared to be acting as an antenna and picking up RF noise present in the laboratory

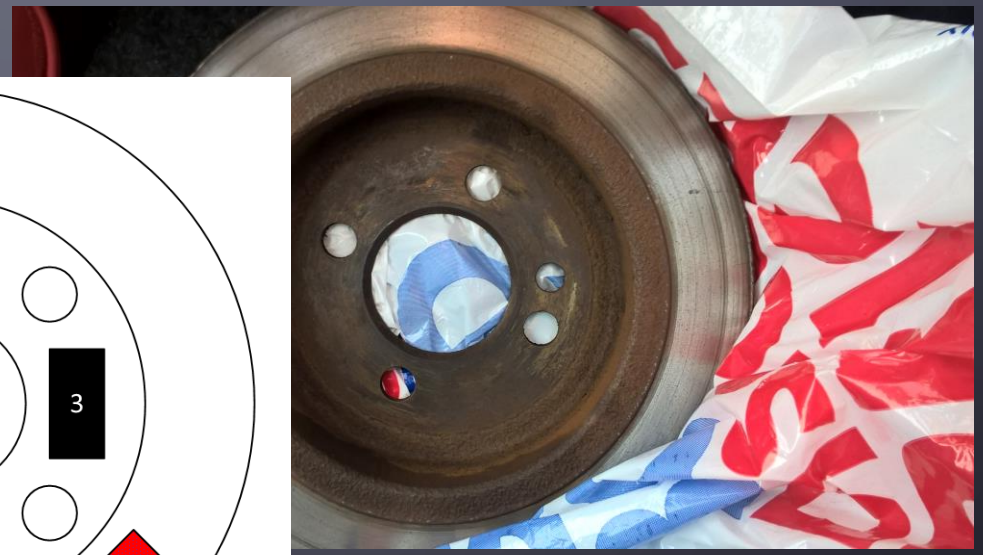
FINAL SENSOR DESIGN

- No dielectric!
- Neodymium magnets
- Shielded coaxial cable

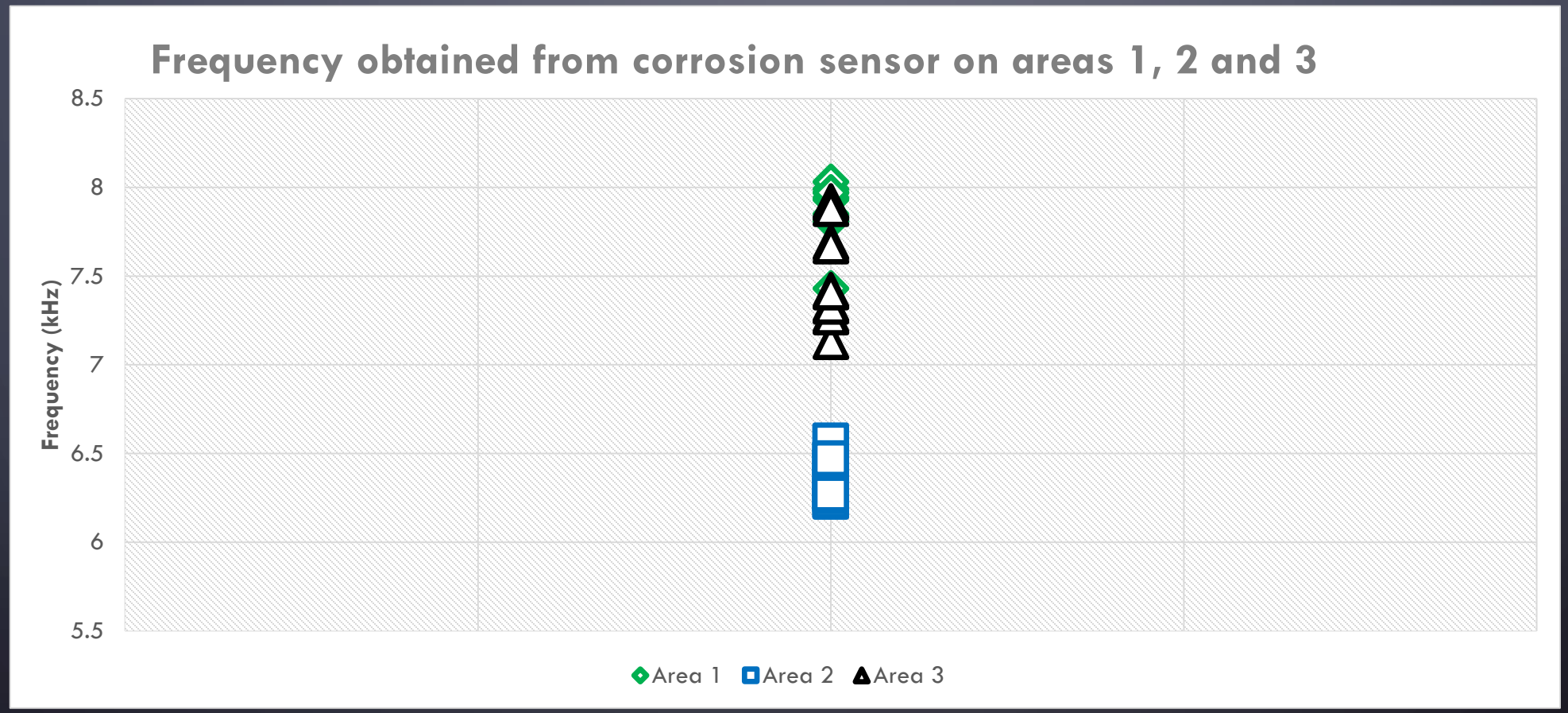
TESTING DIFFERENT RUST THICKNESSES



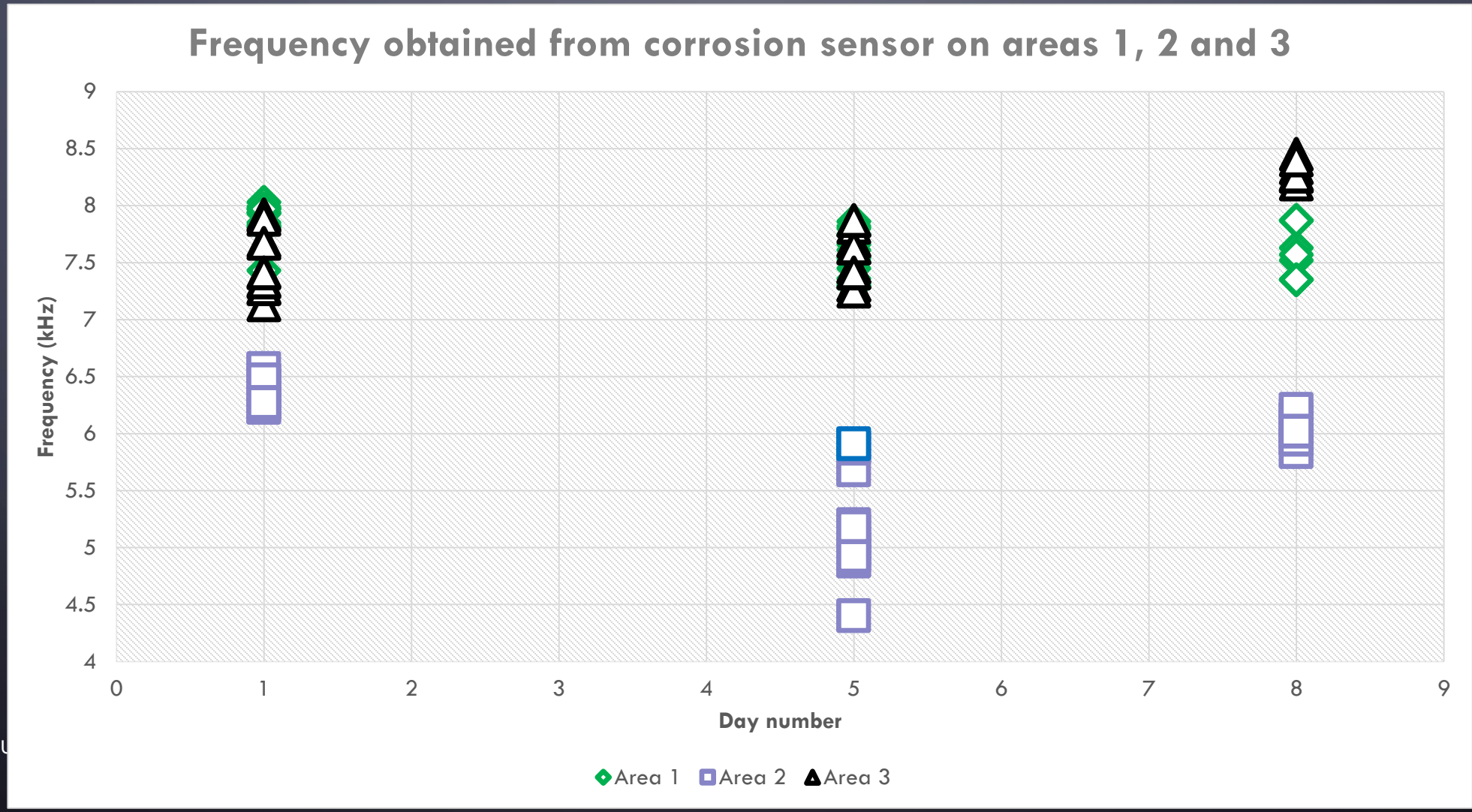




RESULTS


Frequency obtained from corrosion sensor on areas 1, 2 and 3
Frequency (kHz)
8.5
8
7.5
7
6.5
6
5.5
Area 1
Area 2
Area 3

RESULTS


Frequency obtained from corrosion sensor on areas 1, 2 and 3
Frequency (kHz)
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
0
1
2
3
4
5
6
7
8
9
Day number
Area 1
Area 2
Area 3

SOU

RESULTS

- Different areas of the brake disc gave different frequencies
- These changed over time
- More work required!
- Determine whether thickness of rust is a factor in output frequency
- Sensor system detects corrosion in some forms