# Sensor in concrete

**NOTE:** These samples were not made with the simulations in mind so their construction is less precise compared to the free-air sample I provided earlier. There is a lot of variations between what the signatures look like since the impedance depends on so many factors. The goal is to get a similar dataset to the two I show here and if we can get similar changes when do similar damage, there is no need for the signatures to look exactly alike.

## A white cylinder with a hole in it Description automatically generatedSample with window

## These samples are approximately 11cm x 11cm x 24 cm concrete blocks with a 20cm x 0.16cm steel rod reinforcement with a 10mm x 10mm x 0.5mm APC-850 PZT patch attached with a conductive epoxy glue.

## The sample includes a 3D printed triangular prism that acts as a window into the concrete, allowing for easy access to the steel reinforcement without altering the structure of the concrete significantly. Having access to the steel reinforcement makes it possible to simulated corrosion damage by drilling into the steel. Compared to accelerated corrosion testing the drilling method allows for obtaining much faster results with some loss of accuracy of the damage done.

The samples weigh about 5kg. The type of concrete used can be found here:

<https://www.silvan.dk/produkt/skalflex-lyn-beton-25-kg-6220-1699153>

A graph showing a graph

Description automatically generated

A graph of a graph

Description automatically generated

Notice how the damage changes the signature in seemingly unpredictable ways. Shifting left or right and both increasing and decreasing in amplitude at various frequency points. Mainly we are trying to identify the biggest and most defined peak in the dataset since that has the best correlation with damage done to the steel.

A drawing of a rectangular object with a white line

Description automatically generated with medium confidenceThis diagram shows how the steel rod is encased in the center of the concrete with both ends in free air due to the hollow covers attached to the ends of the steel rod. Approximately 6cm of the steel is in direct contact with the concrete. In total, 1cm of the rod is in contact with the cover and 13cm is in free air inside the hollow covers. The PZT patch is attached to one end in the same way as the free air steel rod.

### Description of datasets

The dataset contains measurements from 3 piezos called sample1, sample2 and sample4. Sample1 and Sample2 are inside the same concrete block on the same steel rod, sample4 is in a different concrete block.

Damage scenario ‘Dmg3’ is the same amount of damage as ‘Dmg2’. ‘Dmg3’ was a repeated measurement to ensure impedance signatures didn’t change drastically between measurements.

This is also the case for ‘Dmg5’ which is the same amount of damage as ‘Dmg4’.

Inside each subfolder there will be a text file called weights.txt. This file includes information about the weight of the sample being measured. Notice that Sample1 and Sample2 have the same weights as these 2 piezos are in the same concrete block.

## Humidity test data

A test was conducted to show how relative humidity affects the impedance measurements. A sample very similar to the “sample with window” was used.

A graph of a graph

Description automatically generated

Normally the imaginary part of the impedance isn’t used, but there seems to be a good correlation between the imaginary part of the impedance and relative humidity. This will likely not affect the simulations.

A graph showing a curve

Description automatically generated

A graph with colorful lines

Description automatically generated