# Concrete Compressive Strength Estimation with the SONREB Method

## Discover the benefits, drawbacks and process of estimating the compressive strength of concrete using the SONREB method

## What is SONREB?

SONREB is a compressive strength testing method for concrete. The term SONREB is a combination of sonic and rebound testing. It is a method of combining ultrasonic pulse velocity (UPV) with rebound hammer measurements.

## What are the benefits for compressive strength testing of concrete?

The underlying concept of the combined method is that if the two methods are influenced in different ways by the same factor, their combined use could result in a cancelling effect that improves the accuracy of the estimated strength – Rilem TC-ISC

For example, if we have increased moisture content, the UPV value increases and the rebound value decreases.

The idea behind the technique is to use two methods that are influenced in different ways by the same factor. This helps to provide a more accurate estimate of the compressive strength.

This is what the EN13791 standard has to say about SONREB:

“The combined use of both UPV and rebound hammer techniques with core strength is a useful technique, but the procedures are not detailed in this document.”

There are some countries such as Italy and China for example where the SONREB method is very well known and there are national guidelines for it.

To see the real benefits, let’s look at the coefficient data from the rebound hammer alone, the UPV testing alone, and then both rebound + UPV together….

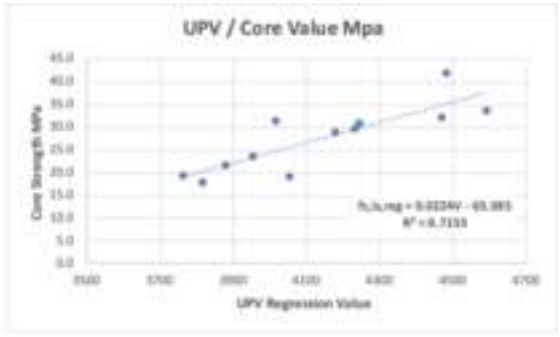
| Test Location | Rebound value | Core Value Mpa | Regression value $f_{c,i,reg}$ |
|---|---|---|---|
| TL 1 | 38.9 | 29.6 | 32.8 |
| TL 5 | 33.6 | 23.7 | 23.8 |
| TL 6 | 36.5 | 32.1 | 28.7 |
| TL 7 | 34.4 | 29 | 25.2 |
| TL 12 | 38.8 | 31.5 | 32.6 |
| TL 13 | 38.3 | 31 | 31.7 |
| TL 16 | 37.7 | 33.7 | 30.7 |
| TL 22 | 31.4 | 18 | 20.1 |
| TL 34 | 43.8 | 42 | 41.0 |
| TL 36 | 31.3 | 21.7 | 19.9 |
| TL 42 | 34.1 | 19.4 | 24.7 |
| TL 43 | 30.9 | 19.1 | 19.3 |

86% Coefficient of determination

Coefficient data from the rebound hammer alone

Above is a correlation made using the rebound hammer alone. As you can see the coefficient of determination is around 86%.

| Test Location | UPV | Core Value Mpa | Regression value $f_{c,i,reg}$ |
|---|---|---|---|
| TL 1 | 4231 | 29.6 | 29.4 |
| TL 5 | 3955 | 23.7 | 23.2 |
| TL 6 | 4470 | 32.1 | 34.7 |
| TL 7 | 4180 | 29 | 28.2 |
| TL 12 | 4016 | 31.5 | 24.6 |
| TL 13 | 4246 | 31 | 29.7 |
| TL 16 | 4591 | 33.7 | 37.5 |
| TL 22 | 3817 | 18 | 20.1 |
| TL 34 | 4482 | 42 | 35.0 |
| TL 36 | 3880 | 21.7 | 21.5 |
| TL 42 | 3762 | 19.4 | 18.9 |
| TL 43 | 4055 | 19.1 | 25.4 |

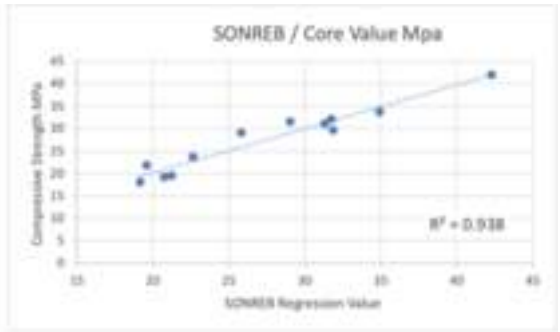


72% Coefficient of determination

Coefficient data from UPV alone

Using the UPV alone, we have a bit more dispersion. The coefficient of determination is 72%.

| Test Location | UPV Value | Rebound value | Regression value $f_{c,i,reg}$ | Core Value Mpa |
|---|---|---|---|---|
| TL 1 | 4231 | 38.9 | 31.866055889 | 29.6 |
| TL 5 | 3955 | 33.6 | 22.61217708 | 23.7 |
| TL 6 | 4470 | 36.5 | 31.73061728 | 32.1 |
| TL 7 | 4180 | 34.4 | 25.79138461 | 29 |
| TL 12 | 4016 | 38.8 | 29.05653111 | 31.5 |
| TL 13 | 4246 | 38.3 | 31.20668765 | 31 |
| TL 16 | 4591 | 37.7 | 34.93186233 | 33.7 |
| TL 22 | 3817 | 31.4 | 19.13014609 | 18 |
| TL 34 | 4482 | 43.8 | 42.25329808 | 42 |
| TL 36 | 3880 | 31.3 | 19.59972186 | 21.7 |
| TL 42 | 3762 | 34.1 | 21.2269598 | 19.4 |
| TL 43 | 4055 | 30.9 | 20.72680844 | 19.1 |



94% Coefficient of determination

Coefficient data from the rebound hammer + UPV

Now when we combine the two using the SONREB regression we get a 94% coefficient of determination. Clearly an impressive result.

# What is the drawback of the SONREB method?

The drawback of using SONREB is that it requires more effort on site, particularly for the UPV measurement on site which requires the grid alignment and two people to do the test.

# How to reduce onsite efforts with SONREB?

It is possible to reduce the onsite effort by using the Schmidt rebound hammer alongside pulse echo technology (UPE). Since 2021, this technique has been included in the European standard as an alternative to classical UPV measurement.

# UPV determination using ultrasonic pulse echo

Let's look at how to use pulse echo technology to determine ultrasonic pulse velocity.

Classical UPV measurements typically measure the P-wave or longitudinal velocity. Pulse echo technology measures the S-wave or shear wave velocity. Either can be used for a correlation to compressive strength, or for simply analysing quality variations. The P- and S-wave velocities are related by the Poisson's ration of the material, so it is possible to convert from one to the other.

Pulse velocity measurements recorded in a grid to see variations

| S-wave Velocity | Corresponding P-wave Velocity | Concrete Quality Classification |
|---|---|---|
| > 2'800 m/s | > 4'500 m/s | Excellent |
| 2'100 – 2'800 m/s | 3'500 – 4'500 m/s | Good |
| 1'700 – 2'100 m/s | 3'000 – 3'500 m/s | Medium |
| < 1'700 m/s | < 3'000 m/s | Doubtful |

Simple concrete quality classification based on pulse velocity

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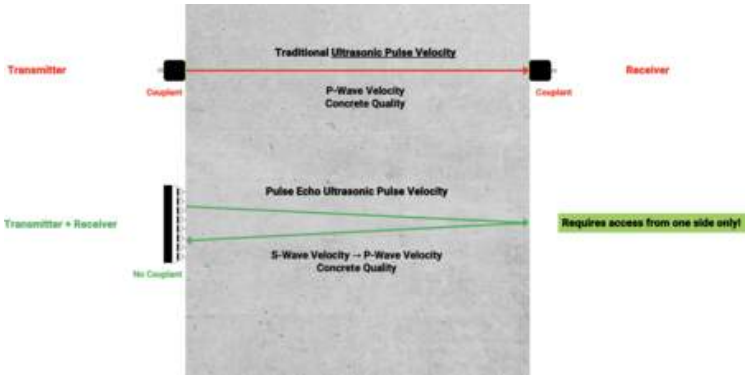
SONREB procedure The SONREB procedure is quite simple. At each test location we need to measure the rebound value and the pulse velocity.

Then we determine the core strength at the same test location. We will repeat this at sufficient locations then use excel to generate the coefficients.

Finally, we can use a spreadsheet function to generate the correlation curve. You can find detailed guidelines on how to do this in this informative [video with David Corbett.]




For your convenience, you can [download a pre-made spreadsheet] from the Screening Eagle website which does this for you like the example below.

**TABLE 1: Raw Data for the Sonreb Method**

| | Compressive Strength fck (MPa or PSI) | Pundit 200 /Lab+ Ultrasonic Pulse Velocity (V) (m/s or ft/s) | Silver-/Original Schmidt Rebound-Values (S) |
|---|---|---|---|
| Sample 1 | 29.6 | 4231 | 38.9 |
| Sample 2 | 23.7 | 3955 | 33.6 |
| Sample 3 | 32.1 | 4470 | 36.5 |
| Sample 4 | 29 | 4180 | 34.4 |
| Sample 5 | 31.5 | 4016 | 38.8 |
| Sample 6 | 31 | 4246 | 38.3 |
| Sample 7 | 33.7 | 4591 | 37.7 |
| Sample 8 | 18 | 3817 | 31.4 |
| Sample 9 | 42 | 4482 | 43.8 |
| Sample 10 | 21.7 | 3880 | 31.3 |
| Sample 11 | 19.4 | 3762 | 34.1 |
| Sample 12 | 19.1 | 4055 | 30.9 |
| Sample 13 | | | |
| Sample 14 | | | |
| Sample 15 | | | |
| Sample 16 | | | |
| Sample 17 | | | |
| Sample 18 | | | |
| Sample 19 | | | |
| Sample 20 | | | |

| | |
|---|---|
| Constant a | 6.33034E-08 |
| Constant b | 1.719667885 |
| Constant c | 1.550755756 |
| R-Square Value | 0.92545377 |

**Step 1:** Select up to twenty (20) test points from different areas that you want to include in the Sonreb calculation. (minimum of five (5) test points required, may also be used on standard cubes or cylinders)

**Step 2:** Obtain pulse velocities and rebound values at these points

**Step 3:** Extract concrete core samples from the selected test areas. The concrete cores should not have any reinforcing bars within the core.

**Step 4:** Perform compressive strength test method on the cores under similar field conditions.

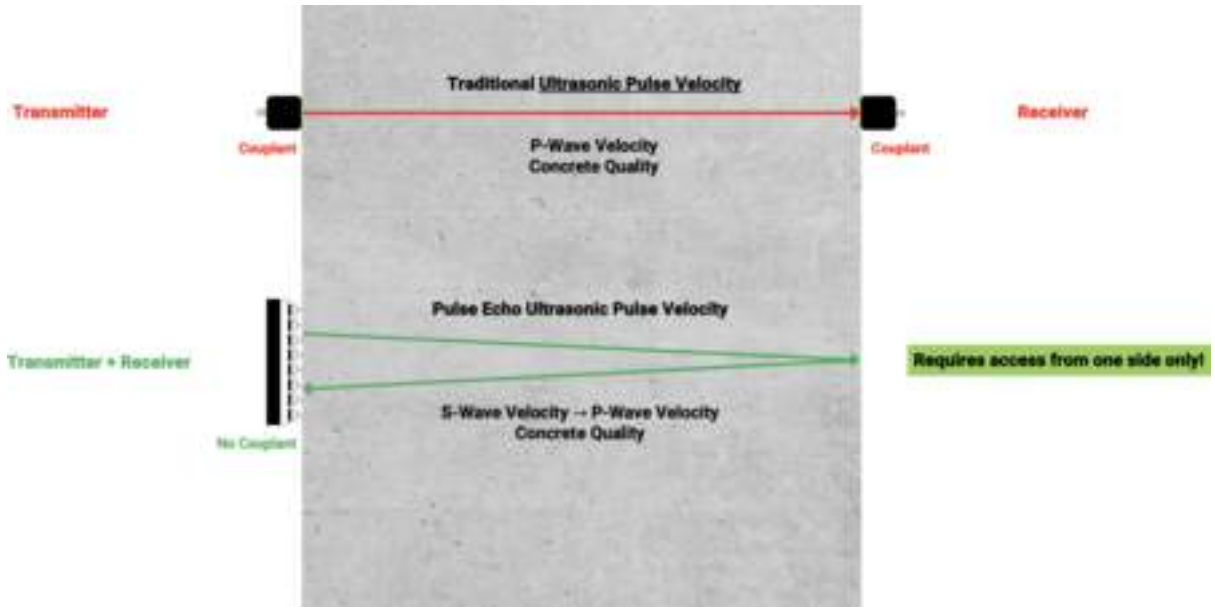
**Step 5:** Input the obtained Compressive Strength, Pundit Lab Ultrasonic Pulse Velocities and the rebound values into Table 1. Input at least five rows of data.

**Step 6:** Once the input data is complete, press control - q (CTRL-q) to obtain constants a, b, c and the R-Square value.

**Step 7:** Once you have the constants, you can create the correlation curve using the Proceq Link software and download it to your Pundit 200 or Pundit Lab+. Alternatively use Sheet "Obtain Comp. Strength", where you have to manually input the pulse velocity reading (V) and the reading from the SilverSchmidt (Q) (or Original Schmidt - R Value) to obtain the compressive strength at that test point.

## Comparing classical UPV with UPE

If we compare classical UPV with the pulse echo method, you will see that there are several practical advantages when it comes to on-site testing.




Most importantly, it only requires access from a single side. Ultrasonic pulse echo also requires no couplant.

## Conclusion

SONREB significantly enhances concrete compressive strength estimation accuracy over single-method testing. While traditional UPV demands resources, pulse echo (UPE) simplifies the on-site application. This efficiency, coupled with improved precision, positions SONREB with UPE as a highly valuable tool for concrete assessment.

Learn more about concrete compressive strength assessment in our dedicated playlist on YouTube.

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