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….

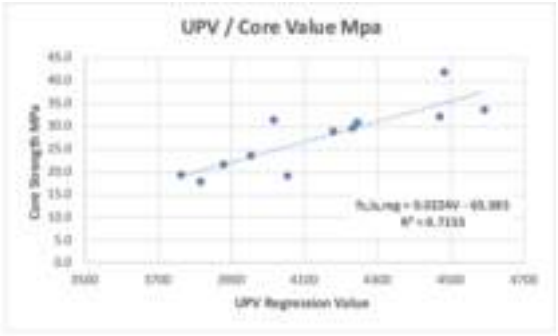
Test Location	Rebound value	Core Value Mpa	Regression value $f_{c,i,reg}$
TL 1	38.9	29.6	32.8
TL 5	33.6	23.7	23.8
TL 6	36.5	32.1	28.7
TL 7	34.4	29	25.2
TL 12	38.8	31.5	32.6
TL 13	38.3	31	31.7
TL 16	37.7	33.7	30.7
TL 22	31.4	18	20.1
TL 34	43.8	42	41.0
TL 36	31.3	21.7	19.9
TL 42	34.1	19.4	24.7
TL 43	30.9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

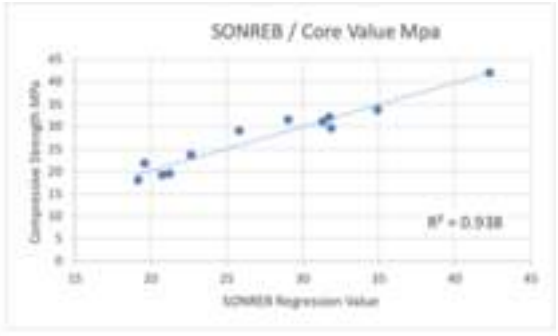


72% Coefficient of determination

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	31.866958689	29.6
TL 5	3955	33.6	22.612217708	23.7
TL 6	4470	36.5	31.73061728	32.1
TL 7	4180	34.4	25.791384861	29
TL 12	4016	38.8	29.016053111	31.5
TL 13	4246	38.3	31.20688765	31
TL 16	4591	37.7	34.931186233	33.7
TL 22	3817	31.4	19.13014605	18
TL 34	4482	43.8	42.25329808	42
TL 36	3880	31.3	19.599721646	21.7
TL 42	3762	34.1	21.2269598	19.4
TL 43	4055	30.9	20.72682844	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

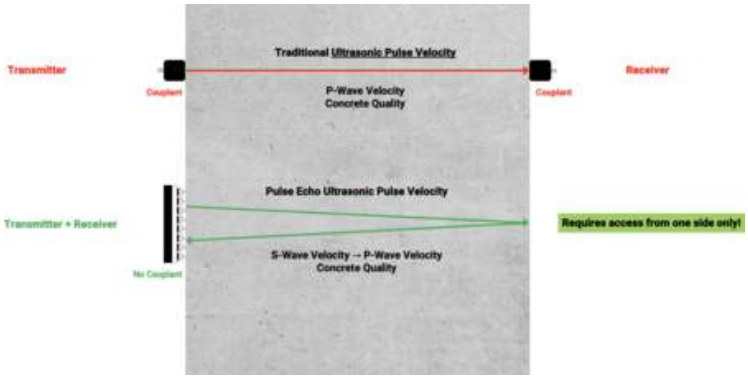
S-wave Velocity	Corresponding P-wave Velocity	Concrete Quality Classification
> 2'800 m/s	> 4'500 m/s	Excellent
2'100 – 2'800 m/s	3'500 – 4'500 m/s	Good
1'700 – 2'100 m/s	3'000 – 3'500 m/s	Medium
< 1'700 m/s	< 3'000 m/s	Doubtful

Simple concrete quality classification based on pulse velocity

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.

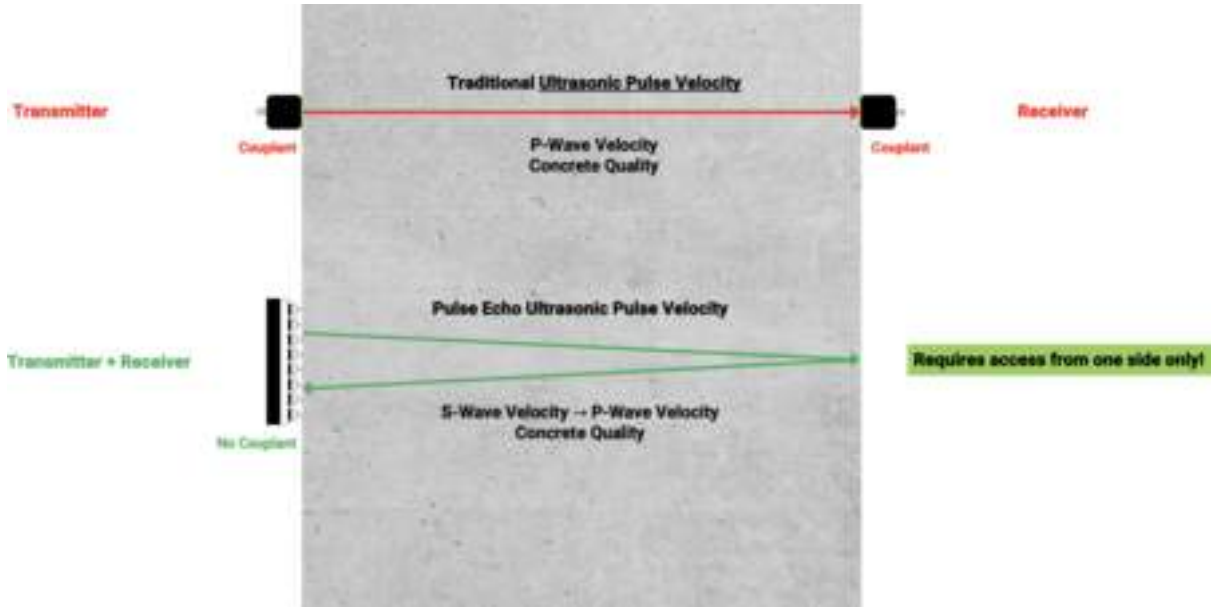
Step 5: Input the obtained Compressive Strength, Pundit Lab Ultrasonic Pulse Velocities and the rebound values into Table 1. Input at least five rows of data.

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.