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ReCreate

Reusing precast concrete for a circular economy

Matthews et al.

Non-Destructive Methods for Estimating Concrete Compressive Strength – Databases

User's Guide & Key

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1. UPV Database Key

Table 1 summarises all parameter descriptions, nomenclature, abbreviations, formulations, and relevant resources used to derive the variables in the accompanying **Ultrasonic Pulse Velocity (UPV)** database. Only those parameters requiring assumptions/calculation are reported here.

Table 1. Descriptions of input parameters included in the UPV database.

Input Parameter	Description
Country	The country where the concrete mix materials were acquired and the concrete specimen cast or structure built.
Specimen Type	The type of specimen which had non-destructive tests (NDTs) applied to it: • *Cylinder – Laboratory*: A cylinder cast in the laboratory. • *Cylinder – On-site*: A cylinder cast at the building site. • *Cylinder – In-situ*: A cylinder drilled from an in-situ element. • *Cube – Laboratory*: A cube cast in the laboratory. • *Element – Laboratory*: The NDT was performed directly on an element cast in the laboratory • *Element – In-situ*: The NDT was performed directly on a building or bridge element in-situ.
Specimen Age (days)	Variable describing the age of the concrete specimen in days.
Rebar Present	The ultrasonic velocity is affected by whether reinforcing steel is in the path of the pulse between transducers. This variable takes a Boolean value of TRUE/FALSE to describe if rebar was present in the specimen being tested, specifically in the direct path of the UPV test.
UPV Device Brand & Model	Description of the UPV device brand and model.
Transducer Diameter (mm)	The diameter of the transducers used during the UPV test, typically 50 mm.
Transducer Frequency (kHz)	The frequency of the ultrasonic waves sent by the transmitting transducer used during the UPV test.

Table 1. (cont.)

Input Parameter	Description
Standard	The national standard followed during the UPV tests outlining the test procedure, limitations, applications, etc.
Test Type	The transmission type used, which is either: • Direct transmission • Semi-direct transmission • Indirect transmission
No. Tests	The number of UPV tests applied at a given test location. The reported result is therefore the average velocity of the given number of tests.
Average Velocity, V_p (m/s)	The average velocity from the UPV tests calculated from the measured transmission time and distance between transducers.
Compression Specimen	The type of specimen geometry used to determine the compressive strength at the location of the UPV test. • Cylinder • Cube • Core
Height (mm)	Height of the core specimen directly before compression testing. Note that this is not the initial drilled length but the final trimmed length before testing.
Width/Diameter (mm)	Width (for cubes) or diameter (for cylinders) of the concrete specimen subjected to compression testing.
Max Aggregate Size (mm)	Maximum permissible sieve size of the coarse aggregate used in the concrete mix.
W/C Ratio	Water/cement ratio applied during concrete mixing.
Strength Class	The classification of the concrete grade related to the UPV specimen.
Design Strength, f_{ck} (MPa)	The characteristic strength of the specified concrete grade. Different countries relate their characteristic values to different reference shapes of cylinders or cubes. Only the nationally classified characteristic value is reported here.

Table 1. (cont.)

Input Parameter	Description
$f_{c,core}$ (MPa)	The raw compression strength results from the concrete specimen subjected to compression testing.
$f_{c,ref}$ (MPa)	Concrete compressive strength normalised to reference geometries of 150x150x150 mm for cubes and 150x300 mm for cylinders. The conversion factors to normalise the geometries are taken from Reineck et al. (2010). See the accompanying journal paper for more details regarding the normalisation methodology.
$f_{c,cyl}$ (MPa)	Reference cubes are then converted to cylinders using the following bilinear approximation proposed by Reineck et al. (2010) to complete the two-step normalisation method: $f_{c,cyl} = \begin{cases} 0.83 \cdot f_{c,cu150}, & if\ f_{c,cyl} \leq 54\ \mathrm{MPa} \\ 1.0 \cdot f_{c,cu150} - 11.1, & if\ f_{c,cyl} > 54\ \mathrm{MPa} \end{cases}$

2. Rebound Hammer Database Key

Table 2 summarises all parameter descriptions, nomenclature, abbreviations, formulations, and relevant resources used to derive the variables in the accompanying **Rebound Hammer (RH)** database. Only those parameters requiring assumptions/calculation are reported here.

Table 2. *Descriptions of input parameters included in the RH database.*

Input Parameter	Description
Country	The country where the concrete mix materials were acquired and the concrete specimen cast, or structure built.
Specimen Type	The type of specimen which had non-destructive tests (NDTs) applied to it: • *Cylinder – Laboratory*: A cylinder cast in the laboratory. • *Cylinder – On-site*: A cylinder cast at the building site. • *Cylinder – In-situ*: A cylinder drilled from an in-situ element. • *Cube – Laboratory*: A cube cast in the laboratory. • *Cube – On-site*: A cube cast at the building site. • *Element – Laboratory*: The NDT was performed directly on an element cast in the laboratory • *Element – In-situ*: The NDT was performed directly on a building or bridge element in-situ. • *Laboratory*: The laboratory specimen type was not specified. • *In-situ*: The in-situ specimen type was not specified.
Specimen Age (days)	Variable describing the age of the concrete specimen in days.
Rebar Present	The ultrasonic velocity is affected by whether reinforcing steel is in the path of the pulse between transducers. This variable takes a Boolean value of TRUE/FALSE to describe if rebar was present in the specimen being tested, specifically in the direct path of the RH test.
RH Device Brand & Model	Description of the RH device brand and model.
Standard	The national standard followed during the RH tests outlining the test procedure, limitations, applications, etc.

Table 2. (cont.)

Input Parameter	Description
Orientation	The orientation of the rebound hammer used during the test. If the test was performed vertically, corrections to the given rebound number must be applied to account for the effects of gravity.
No. Tests	The number of RH tests applied at a given test location. The reported result is therefore the average velocity of the given number of tests.
Median Rebound Number, RN	The median rebound number from the sample of tests performed at the same general location.
Compression Specimen	The type of specimen geometry used to determine the compressive strength at the location of the RH test. • Cylinder • Cube • Core
Height (mm)	Height of the core specimen directly before compression testing. Note that this is not the initial drilled length but the final trimmed length before testing.
Width/Diameter (mm)	Width (for cubes) or diameter (for cylinders) of the concrete specimen subjected to compression testing.
Max Aggregate Size (mm)	Maximum permissible sieve size of the coarse aggregate used in the concrete mix.
W/C Ratio	Water/cement ratio applied during concrete mixing.
Strength Class	The classification of the concrete grade related to the RH specimen.
Design Strength, f_{ck} (MPa)	The characteristic strength of the specified concrete grade. Different countries relate their characteristic values to different reference shapes of cylinders or cubes. Only the nationally classified characteristic value is reported here.

Table 2. (cont.)

Input Parameter	Description
$f_{c,core}$ (MPa)	The raw compression strength results from the concrete specimen subjected to compression testing.
$f_{c,ref}$ (MPa)	Concrete compressive strength normalised to reference geometries of 150x150x150 mm for cubes and 150x300 mm for cylinders. The conversion factors to normalise the geometries are taken from Reineck et al. (2010). See the accompanying journal paper for more details regarding the normalisation methodology.
$f_{c,cyl}$ (MPa)	Reference cubes are then converted to cylinders using the following bilinear approximation proposed by Reineck et al. (2010) to complete the two-step normalisation method: $f_{c,cyl} = \begin{cases} 0.83 \cdot f_{c,cu150}, & if\ f_{c,cyl} \leq 54\text{ MPa} \\ 1.0 \cdot f_{c,cu150} - 11.1, & if\ f_{c,cyl} > 54\text{ MPa} \end{cases}$

3. SonReb Database Key

Since all SonReb variables are shared among the UPV and RH databases, all of the necessary descriptions can be found in Tables 1 and 2.

References

Reineck, K. H., Kuchma, D. A., & Fitik, B. (2010). *Research Report NER050*: *Extended Databases with Shear Tests on Structural Concrete Beams without and with Stirrups for the Assessment of Shear Design Procedures.* United States of America Nuclear Regulatory Commission.