# CiviLab 7.1 — Validation manual

Bakhti Softwares — edition 7.1

## 1. Purpose

This document compares the results of CiviLab with values calculated according to the reference standards and methods, on the data sets of the workbook **docs/verification/Validation-Essais-7.1.xlsx**. Each row gives the standard, the case, the expected value, the CiviLab value and how it was obtained.

## 2. Method

- **Run**: the calculation functions of CiviLab (source code of version 7.1) were compiled and run on the data of the workbook; the CiviLab value is the result of this calculation.
- **Code checked**: the formula of the code was reviewed and compared with the standard; the CiviLab value given is the one this formula gives. A check in the software is recommended.
- Expected value: formulas of the workbook (standard cited). Data: published example (ACI 211.1 example 1; real triaxial tests Waterloo and BGS) or constructed validation set (plausible, unmeasured values).

## 3. Results

| Family | Test | Standard | Case | Expected | CiviLab | Mode | Code |
|---|---|---|---|---|---|---|---|
| Concrete | ACI mix design | ACI 211.1-91 ex. 1 | Water / cement / coarse aggregate / sand (kg/m³) | 181 / 289.1 / 1136 / 774.4 | 181 / 289.1 / 1136 / 774.4 | **Run** | BetonFormulation.vb ACIMethod.Proportionner; test FormulationACI.vb |
| Concrete | ACI mix design | ACI 211.1-91 ex. 1 | Water to add (kg/m³) — published ACI: 123 | 122.9 | 122.9 | **Run** | same |
| Concrete | Compression | NF EN 12390-3 | Cube 10 cm, F = 262.4 kN (MPa) | 26.2 | 26.2 | Code checked | EcrasementBeton.xaml.vb SurfaceEprouvette (0.01 m²) |
| Concrete | Rebound hammer | NF EN 12504-2:2021 § 8 | Zone Z1: integer median | 32 | 32 | **Run** | TestSimples.vb Sclerometre.IndiceRebond; test Sclerometre.vb |
| Concrete | Rebound hammer | ASTM C805-13a § 9.1 | Zone Z1: mean with rejection | 31.33 | 31.33 | **Run** | same |
| Concrete | Rebound hammer | EN 12504-2 / ASTM C805 | Scattered zone Z2 | rejected | rejected (NaN) | **Run** | same |
| Concrete | Ultrasonic pulse velocity | NF EN 12504-4 | V = L/t, point P1 (m/s) | 4161 | 4161 | Code checked | UltrasonFrm.xaml.vb: DIS·10000/Temps |
| Concrete | SonReb | Meynink 1979 (correlation) | N = 35, V = 4200 m/s (MPa) | 34.5 | 34.5 | Code checked | EssaiCombineeFrm.xaml.vb Resistance — correlation not checked against the publication |

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|---|---|---|---|---|---|---|---|
| Concrete | Dreux-Gorisse | Dreux & Festa | YA (%); water (L/m³) | 46.13; 184.2 | identical | Code checked | BetonFormulation.vb YA, C0…C3, K |
| Concrete | Bolomey | Bolomey 1925 | P(0.08 mm) (%); water (L/m³) | 15.1; 189.8 | identical | Code checked | BetonFormulation.vb CalculerPoints (A.X = 0) |
| Concrete | Faury | Faury 1941 (Univ. Tlemcen course) | Break-point ordinate (%); water (L/m³) | 60.87; 154.5 | identical | Code checked | BetonFormulation.vb BetonFaury (K') |
| Laboratory | Proctor | NF P 94-093 | w opt (%); ρd max (2nd degree) | 12.78; 1.879 | identical (2nd degree) | Code checked | Proctor.vb CalculerPolynome / Obtimum |
| Laboratory | Atterberg limits | NF P 94-051 / 94-052-1 | wL Casagrande; cone 17 mm (%) | 45.7; 44.6 | identical | Code checked | Feuille.vb / EssaiFeuille.LimitesCisaillement.vb |
| Laboratory | CBR | NF P 94-078 | CBR index | 22.2 | 22.2 | Code checked | CBRClass.vb CBRValueCalculation (13.35 / 19.93 kN) |
| Laboratory | Los Angeles | NF EN 1097-2 | LA | 22.6 | 22.6 | Code checked | EssaiFeuille.LaboRoutesBeton.vb |
| Laboratory | Micro-Deval | NF EN 1097-1 | MDE | 13.8 | 13.8 | Code checked | same |
| Laboratory | Sand equivalent | NF EN 933-8 | Mean SE | 77.0 | 77.0 | Code checked | same |
| Laboratory | Particle size | NF EN 12620 annex B | FM; Cu; Cc | 2.68; 5.26; 0.84 | identical | Code checked | TamisageClass.vb ModuleFinesse, FacteurUniformite, FacteurCourbure |
| Laboratory | Hydrometer | NF P 94-057 | D at t = 30 s (mm) | 0.0751 | identical | Code checked | TamisageClass.vb ParticleDiameter (Stokes) |
| Laboratory | Direct shear | NF EN ISO 17892-10 | c' (kPa); φ' (°) | 16.6; 29.9 | identical | Code checked | Cisaillement.vb (MoindreCarre) |
| Laboratory | Oedometer | NF EN ISO 17892-5 | Cc | 0.172 | identical | Code checked | EssaiOdometrique.vb; e–log σ' slopes |
| Laboratory | Triaxial | NF EN ISO 17892-8/9 | Real tests Waterloo CD, BGS CIU: c', φ' | published | reproduced | **Run** | Triaxial.vb; tests Triaxial.vb (21 tests) |
| Asphalt | Kumagawa | — | External binder content (%) | 5.63 | 5.63 | Code checked | EssaiFeuille.LaboRoutesBeton.vb |
| Asphalt | Paraffin bulk density | NF EN 12697-6 meth. D | ρ (g/cm³) | 2.341 | 2.341 | **Run** | SOLABase.MasseVolumiqueParaffinee |
| Asphalt | Degree of compaction | — | Measurement 1 (%) | 96.6 | 96.6 | Code checked | EssaiFeuille.LaboRoutesBeton.vb |
| In situ | Dynamic penetrometer | NF EN ISO 22476-2 | qd at 0.2 m (MPa) | 3.39 | identical | Code checked | PDLClass.vb (Dutch formula) |
| In situ | CPT | NF P 94-113 / NF EN ISO 22476-1 | Qc = 2.1 kN, Ac = 10 cm²; Qs = 0.75 kN, As = 150 cm² — hand calculation (kN × 10³ = N; cm² × 10⁻⁴ = m²) | qc 2.10 MPa; fs 50.0 kPa | 2.100 MPa; 50.000 kPa | **Code reviewed** | CPTFrm.xaml.vb RecalculerRow: qc = 10·Qc/Ac, fs = 10.000·Qs/As; “CPT” sheet of the workbook |
| In situ | Pressuremeter | NF P 94-110-1 annex D | pl (MPa), hyperbolic curve | 2.006 | 2.006 | **Run** | Module.vb PL; EtalonageVolume.VolumeInitial |
| In situ | Pressuremeter | NF P 94-110-1 § D.2.2 | EM (MPa) | 8.80 | identical | Code checked | PresiommetreMenard.vb Em |

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|---|---|---|---|---|---|---|---|
| Foundations | DTU 13.12 laboratory | DTU 13.12 § 3.2.1 | Nc / Nq / Nγ (φ = 30°) | 30 / 18.4 / 18.1 | 30 / 18.4 / 18.1 | **Run** | FondationClass.vb Calculate* |
| Foundations | DTU 13.12 laboratory | DTU 13.12 § 3.2.1 | sc / sγ / iq / iγ (B/L = 0.75; δ = 10°) | 1.15 / 0.85 / 0.790 / 0.444 | 1.15 / 0.85 / 0.790 / 0.444 | **Run** | same |
| Foundations | DTU 13.12 laboratory | DTU 13.12 § 3.2.1 | qu (kPa) | 626.6 | identical | Code checked | FondationCPhiClass.QnetCalc |
| Foundations | EC7 (NF P 94-261) | EN 1997-1 annex D | Nq / Nγ (φ = 30°); Nc (φ = 0) | 18.40 / 20.09; 5.14 | 18.4 / 20.09; 5.14 | **Run** | FondationClass.vb |
| Foundations | Pressuremeter DTU | DTU 13.12 § 3.2.2 | qu (kPa) | 928.3 | identical | Code checked | FondationPREClass.qu |
| Foundations | CPT DTU | DTU 13.12 § 3.2.3.1 | qu (kPa) | 670.6 | identical | Code checked | FondationCPTClass.qu |
| Foundations | SPT | Meyerhof 1956 | q (kPa) | 239.1 | identical | Code checked | FondationSPTClass.CapaciteSansCharge |
| Stability | Slope — Bishop | Bishop (1955); ACADS (Giam and Donald 1989) | Simple slope 1(a): F (ACADS reference 1.00; GeoStudio 0.993) | 1.00 | 0.985 | **Run** | StabiliteTalus.vb; tests StabiliteTalus.vb |
| Stability | Slope — Bishop | ACADS non-homogeneous | 3 layers: F (reference 1.39; GeoStudio 1.413) | 1.39 | 1.393 | **Run** | same |
| Stability | Slope — Bishop | Moment equilibrium (φ = 0) | c = 30 kPa: exact F by integration | 1.39264 | 1.39259 | **Run** | same |
| Stability | Slope — EC7 | NF P 94-270 §10, annex C | Fd (A2 + M2) on the ACADS 1(a) circle, Excel slice-by-slice recalculation | 0.788 | 0.788 | **Run** | workbook, sheet “Stabilité talus (Bishop)” |
| Stability | Slope — Morgenstern-Price | Morgenstern and Price (1965); ACADS non-homogeneous (GeoStudio §2.3) | 3 layers: F (reference 1.39; GeoStudio M-P 1.382) | 1.382 | 1.365 | **Run** | tests StabiliteTalus.vb |
| Stability | Slope — Spencer, M-P | Moment equilibrium (φ = 0) | Spencer = M-P = exact equilibrium | 1.39264 | 1.39258 | **Run** | same |
| Stability | Slope — M-P (Excel) | Zhu et al. (2005); ACADS 1(a) circle | F, λ iterations in Excel formulas | 0.98410 (λ 0.529) | 0.98410 | **Run** | workbook, sheet “Talus Morgenstern-Price” |
| Stability | Slope — earthquake | ACADS non-homogeneous, kh = 0.15 (GeoStudio §2.4) | Bishop (GeoStudio 1.016); M-P (GeoStudio 0.989); reference 1.00 | 1.016 / 0.989 | 1.011 / 0.983 | **Run** | tests StabiliteTalus.vb |
| Stability | Slope — earthquake (Excel) | Fellenius, Bishop, Spencer, ACADS 1(a) circle, kh = 0.15 | Slice-by-slice recalculation | 0.68711 / 0.71586 / 0.71711 | identical | **Run** | sheets “Talus séisme (Bishop)”, “Talus Morgenstern-Price” |
| Stability | Seismic kh, kv | RPA 2024 §10.3 (10.22, 10.23); NF P 94-270 I.4 | Zone V, group 2, S2: kh = A·I·S/3; NF: ag/g 0.2, S 1.2 | 0.100 / 0.050; 0.120 / 0.060 | identical | **Run** | sheet “Séisme kh kv”; tests |
| Stability | Slope — weak layer | ACADS, specified surface (GeoStudio §2.8) | M-P on the published polygonal surface (ACADS reference 1.34) | 1.261 | 1.260 | **Run** | tests StabiliteTalus.vb |

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|---|---|---|---|---|---|---|---|
| Stability | Slope — weak layer (Excel) | ACADS §2.8; Zhu et al. (2005) | F, λ iterations in Excel formulas, M-P / Spencer | 1.26033 / 1.27602 | identical | **Run** | sheet “Talus surface imposée (M-P)” |
| Stability | Slope — three blocks | ACADS, search (GeoStudio §2.7); NF P 94-270 fig. 10.4 | Automatic search, M-P (reference 1.26) | 1.261 | 1.243 | **Run** | same |
| Settlement | Ménard | NF P 94-261 annex H | sc; sd (cm) | 0.40; 0.85 | 0.40; 0.85 | **Run** | TassementClass.vb Sc, Sd |
| Settlement | Oedometric | NF P 94-261 / DTU 13.12 § 3.3.1 | s (cm) | 48.5 | identical | Code checked | TassementOedometer.ComputeSc |
| Settlement | Elastic | — | s (cm) | 1.28 | identical | Code checked | TassementLinear.Tassement |

## 4. Corrections made in version 7.1 following this validation

- ACI 211.1: f'cr > 35 MPa, fineness modulus < 2.40, air, rounded gravel, admixtures, single calculation.
- Bolomey: origin of the reference curve; Faury: origin and K' term.
- Compression: area of the 10 cm cube; rebound hammer: index according to EN 12504-2 / ASTM C805.
- Pressuremeter: limit pressure according to NF P 94-110-1 annex D; calibrated initial volume validated.
- Ménard settlement (US units), EC7 factors Nq/Nc, DTU iγ, ASTM fineness modulus.

## 5. Limits

- **CPT**: qc = 10·Qc/Ac and fs = 10,000·Qs/As (Qc, Qs in kN; Ac, As in cm²; calculation revised in 7.1); CPT tests saved with an earlier version must be reopened and saved again (“Add/Modify”); CPT is not yet exported to AGS4.
- Empirical correlations (SonReb, rebound hammer, ultrasonic): applied as published, not rechecked against the original articles.
- DTU 13.12 design stress: the standard gives q = qu/2; CiviLab applies γD + (qu − γD)/F (choice kept).
- EC7 / NF P 94-261, pressuremeter and CPT methods: not rechecked against the text of the standard.
- Slope stability: no reinforcement or tension crack; pseudo-static earthquake only (not applicable to liquefiable soils); the searches of CiviLab find F values slightly lower than GeoStudio (more unfavourable surfaces).

All “expected” values can be recalculated in the Excel workbook; the data can be changed there for other cases.