Benchmark Example No. 49

Triaxial Drained Test

SOFiSTiK | 2022

VERiFiCATiON
BE49 Triaxial Drained Test

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SOFiSTiK AG

HQ Nuremberg
Flataustraße 14
90411 Nürnberg
Germany

T +49 (0)911 39901-0
F +49(0)911 397904

Office Garching
Parkring 2
85748 Garching bei München
Germany

T +49 (0)89 315878-0
F +49 (0)89 315878-23

info@sofistik.com
www.sofistik.com

Front Cover

Arnulfsteg, Munich Photo: Hans Gössing

Overview	
Element Type(s):	CAXI
Analysis Type(s):	MNL
Procedure(s):	LSTP
Topic(s):	SOIL
Module(s):	TALPA
Input file(s):	triaxial_d_test.dat, triaxial_d_test_100.dat

1 Problem Description

In this example a drained (D) triaxial test on a loose Hostun-RF sand is simulated. The specimen is subjected to different levels of triaxial confining stresses and the results are compared to those of the experimental tests and numerical simulations, as described in Wehnert [1].

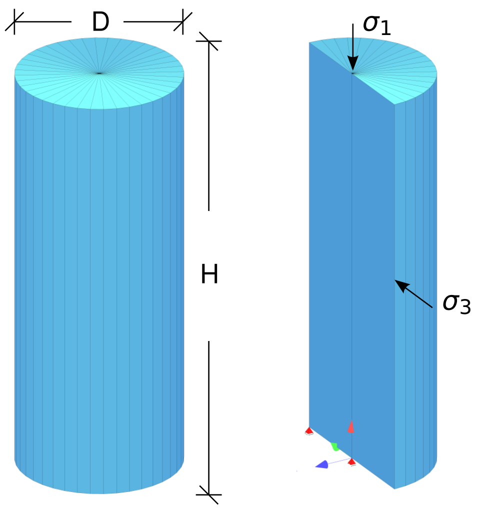

Figure 1: Problem Description

2 Reference Solution

In this example, the same triaxial test described in Benchmark 48 is examined, but for the case of a drained sample. Two soil models are utilised, the Mohr-Coulomb (MC) and the Hardening Soil (HS) model with different dilatancy configurations. Further details on the material models can be found in Benchmarks 48.

3 Model and Results

The properties of the model are presented in Table 1. Two material models are considered: the Mohr-Coulomb and the Hardening Soil, which is combined with the different dilatancy configurations as described by the formulations presented in Section 2 in Benchmark 48.

The analysis is carried out using an axisymmetric model. Two confining stress levels are considered, $\sigma_c = 100$ and $300\ kPa$. The drained triaxial test on loose Hostun-RF sand is used as a reference. More information about Hostun-RF sand can be found in Wehnert [1] and Benchmark 48.

Table 1: Model Properties

Material		Geometry	Loading
$E = 60.0\ MN/m^2$	$E_{s,ref} = 16.0\ MN/m^2$	$H = 0.09\ m$	Phase I:
$\nu_{ur} = 0.25$	$E_{50,ref} = 12.0\ MN/m^2$	$D = 0.036\ m$	$\sigma_1 = \sigma_3 = \sigma_c =$
$\gamma = 0.0\ MN/m^3$	$m = 0.75$		$= 100, 300\ kPa$
$c' = 0.01\ kN/m^2$	$R_f = 0.9$		Phase II:
$\varphi' = 34°$	$K_0 = 0.44$		$\sigma_3 = \sigma_c = 100, 300\ kPa$
$\psi = 2°$	$B = 0.9832$		$\sigma_1 = \sigma_a > \sigma_c$
$\psi_0 = -4°$			

The results, as calculated by SOFiSTiK, are presented in Figures 2 - 8 (MC, HS-Rowe, HS-Cons, HS-Soreide and HS-Wehnert). Figures 2 - 7, also include the results of the numerical simulations and of the experimental tests from Wehnert [1] (Wehnert, Exp. 1 and Exp. 2). On a $p-q$ diagram the Mohr-Coulomb failure condition (MC failure) based on the used shear parameters, c' and φ', is also displayed.

If we first analyse the reference curves from Wehnert [1], we will notice, that the agreement between the numerical simulation and the experimental tests is quite good.

Comparing the SOFiSTiK results for the HS model with the dilatancy model acc. to Wehnert (HS-Wehnert) with the reference numerical results from Wehnert [1], we can notice that the stress paths p-q are captured exactly for both σ_c-stress levels. Accordingly, the deviatoric stress q versus the axial strain ϵ_1 curve fits very well to the reference results. For the case of the strain curves some deviation in results is identified and it seems that the Soreide dilatancy model shows better agreement with the simulation results from Wehnert.

3.1 Hostun-RF Sand, $\sigma_c = 100\ kN/m^2$

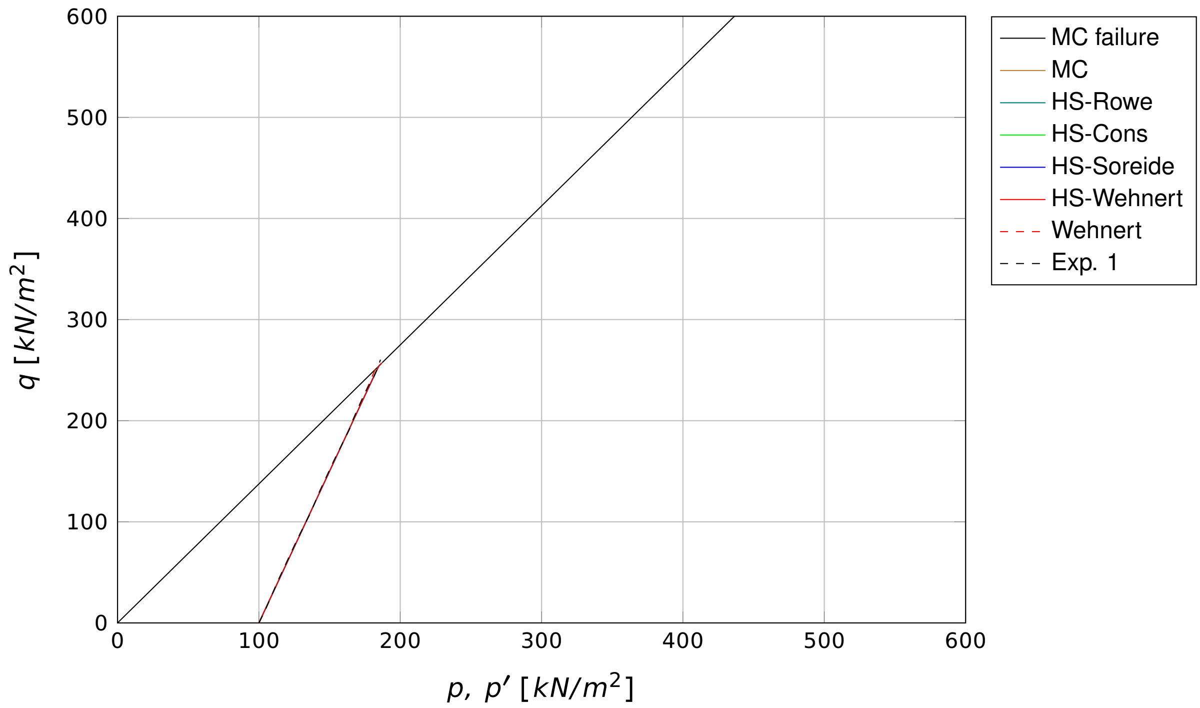

Figure 2: Effective stress path curve (q-p)

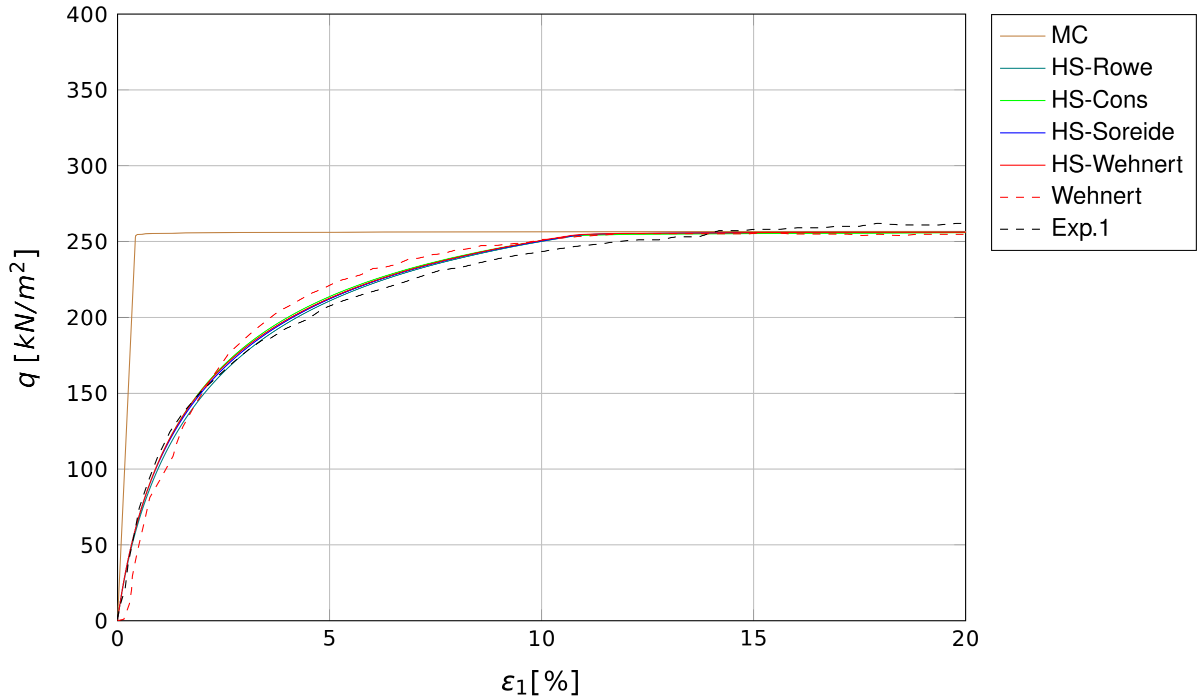

Figure 3: Deviatoric stress - axial strain curve (q-ε_1)

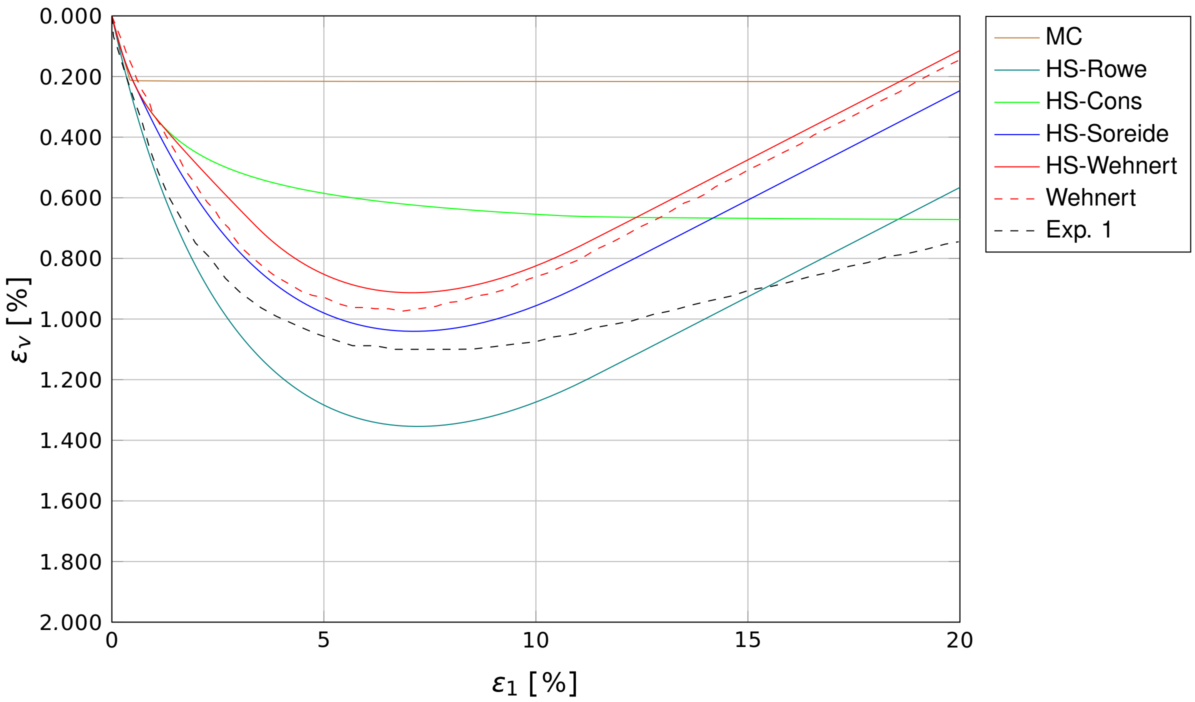

Figure 4: Volumetric strain - axial strain curve (ε_v-ε_1)

3.2 Hostun-RF Sand, $\sigma_c = 300\ kN/m^2$

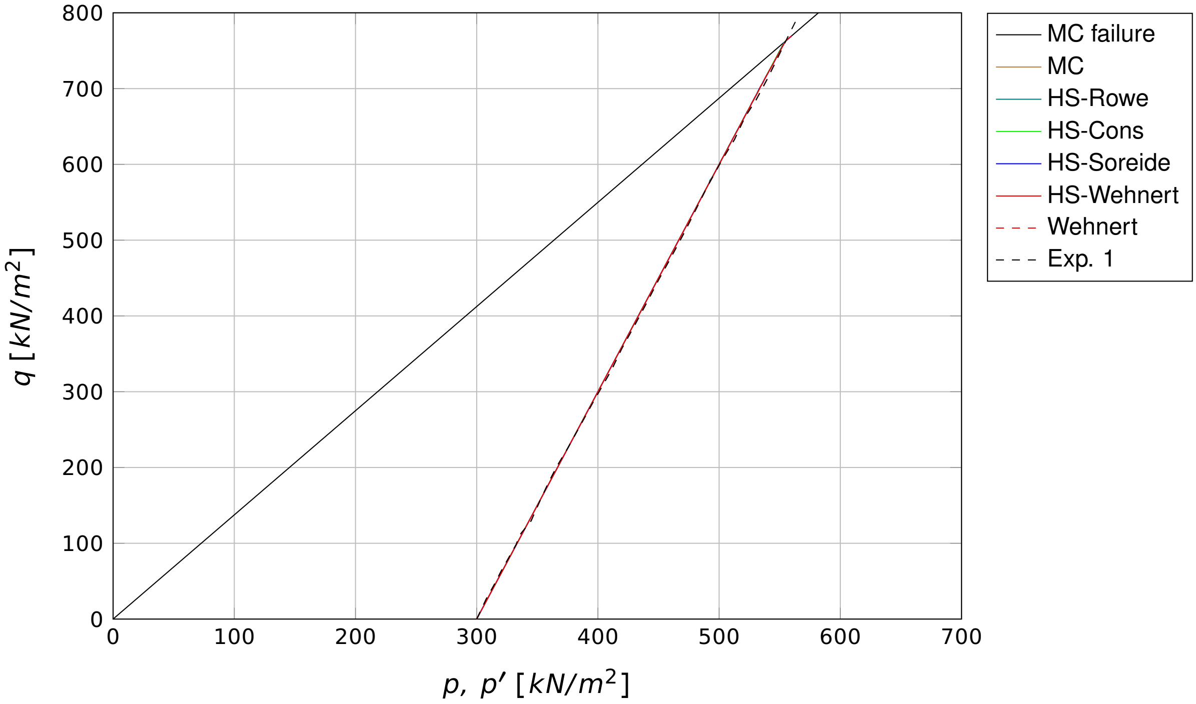

Figure 5: Effective stress path curve (q-p)

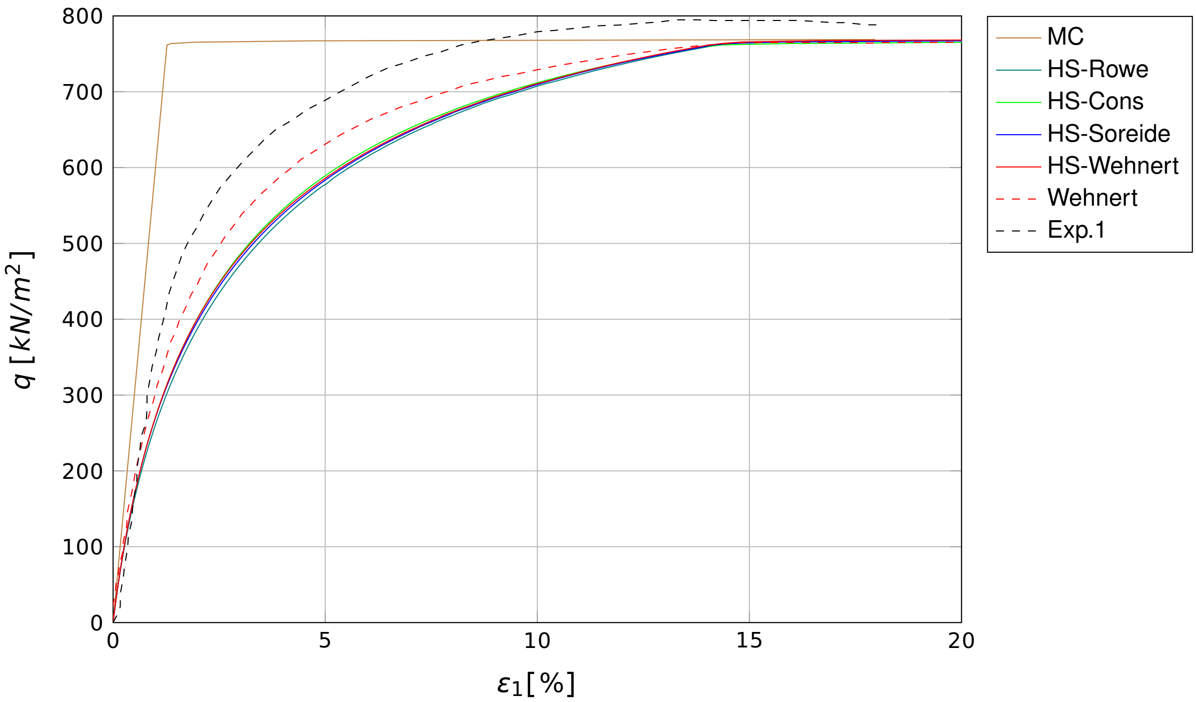

Figure 6: Deviatoric stress - axial strain curve (q-ε_1)

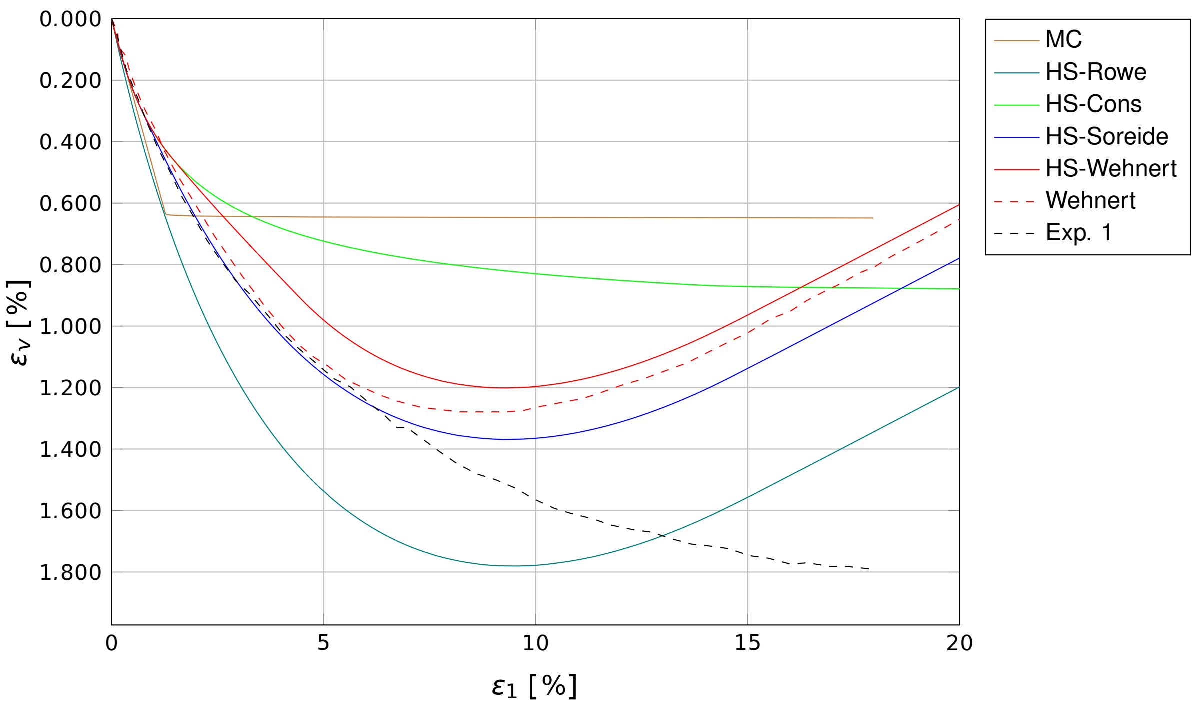

Figure 7: Volumetric strain - axial strain curve (ε_v-ε_1)

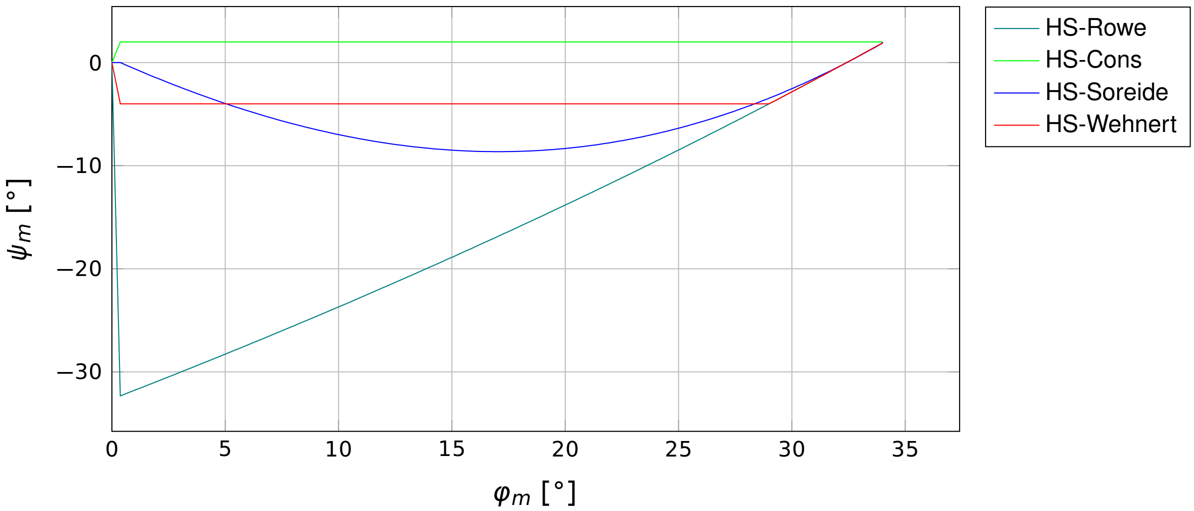

Figure 8: Mobilised dilatancy angle - friction angle curve (ψ_m-φ_m)

4 Conclusion

This example, concerning the triaxial test of a loose consolidated undrained sand soil, verifies that the results obtained by the Hardening Soil material model with a cut-off in the dilatancy are in a good agreement with the solution given by Wehnert [1].

5 Literature

[1] M. Wehnert. *Ein Beistrag zur dreainerten und undrainerten Analyse in der Geotechnik.* Institut für Geotechnik, Universität Stuttgart: P. A. Vermeer, 2006.