Dafalias-Manzari 04 Model, v3.2
for FLAC3D v7.0

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Introduction

The Dafalias-Manzari model (Dafalias & Manzari, 2004) version 1.0 was implemented in 2012 for FLAC3D v5.0. **This version (v3.2) is for FLAC3D v7.0.**

It is a stress-ratio controlled, critical state compatible sand model, which takes into account the effect of fabric changes in the multi-axial generalization. One of the merits of this model is that one set of material parameters can be applied to dramatically different stresses and densities. The material parameters have been well calibrated for Toyoura sand. Some material parameters are considered default values for most sands and need not to be determined separately for other sands.

The detailed background on the model is given in the paper by Dafalias & Manzari (2004). The implementation of the model in *FLAC3D* can be find in the paper by Cheng et al (2013). When using this DLL file for any reports or publications, the above two papers should be cited.

Model Properties/Parameters

Name	**Description**	**Calibrated values for Toyoura Sand (Dafalias & Manzari 2004)**
Input Material Properties:		
G0	Material constant to calculate the elastic moduli, G_0	125.0
Patm	Reference pressure to normalize the current pressure in calculation of elastic moduli, the standard atmospheric pressure (~100 KPa) is recommended, p_{at}	100.0 (if in KPa)
poisson	Poisson's ratio, v	0.05
Mc	Critical state ratio, M	1.25
c	Ratio of the triaxial extensive strength to compressive strength, c	0.712
lambda	Parameter to define the critical state line, λ_c	0.019
ec0	Parameter to define the critical state line, e_{c0}	0.934
xi	Parameter to define the critical state line, ξ , it is value is 0.7 for most sands	0.7, the default value 0.7 may be valid for most sands.

mm	Parameter to define the yield function, m, a value in the range of (0.01-0.05)	0.01-0.05, the default value is 0.01.
h0	Parameter for the plastic modulus, h_0	7.05
ch	Parameter for the plastic modulus, c_h	0.968
nb	Parameter for the plastic modulus, n^b	1.25 (originally 1.1)
A0	Parameter for dilatancy, A_0	0.704
nd	Parameter for dilatancy, n^d	2.1 (originally 3.5)
zmax	Parameter for fabric-dilatancy tensor, z_{max}	2.0 ~ 6.0, the default value is 2.0.
cz	Parameter for fabric-dilatancy tensor, c_z	600
Auxiliary Material Properties:		
kcut	Cut-off factor to deal with low pressures	0.01 (default value, if not input)
flag-ini	If reset to zero, the property set will be re-initialized.	0 by default, will become 1 once the property set has been initialized.
flag-origin	If equal to 1, the fabric tensor will be set to the origin position to avoid possible overshooting.	0 by default.
Input Initial Conditions:		
evd0	Initial void ratio, e^0	• Must be input. • Once input, the values is fixed.
sxx-ini	Initial effective stress, xx-component	• Must be input one or some. • The default value is 0 if not input. • Can be input through commands or a FISH function. • Once input, the values is fixed.
syy-ini	Initial effective stress, yy-component	
szz-ini	Initial effective stress, zz-component	
sxy-ini	Initial effective stress, xy-component	
syz-ini	Initial effective stress, yz-component	
sxz-ini	Initial effective stress, xz-component	
zxx	Current fabric dilatancy tensor, xx-component	• The default value is 0. • Most cases all components are initialized from 0. • Can be evolved after initiation.
zyy	Current fabric dilatancy tensor, yy-component	
zzz	Current fabric dilatancy tensor, zz-component	
zxy	Current fabric dilatancy tensor, xy-component	
zyz	Current fabric dilatancy tensor, yz-component	
zxz	Current fabric dilatancy tensor, xz-component	
Output Material Properties:		
void	Current void ratio	
sp	Current state parameter	
cycles	Current cycles	Variation could be ±0.25 cycles.

Note: The initial void ratio and initial stress must be specified (or the initial stress derived from the previous calculation stage) before the model running. After the initial stresses are set, or derived from previous calculation, the FISH function to assign initial effective stress can be as below:

```
fish operator ini_stress(modelname, zp)
  if zone.model(zp) = modelname
    local pp = zone.pp(zp)
    zone.prop(zp,'sxx-ini') = zone.stress.xx(zp) + pp
    zone.prop(zp,'syy-ini') = zone.stress.yy(zp) + pp
    zone.prop(zp,'szz-ini') = zone.stress.zz(zp) + pp
    zone.prop(zp,'sxy-ini') = zone.stress.xy(zp)
    zone.prop(zp,'sxz-ini') = zone.stress.xz(zp)
    zone.prop(zp,'syz-ini') = zone.stress.yz(zp)
  endif
end
[ini_stress('dafalias', ::zone.list)]
```

Included DLL file

modeldafalias007.dll	Dynamic Link Library (DLL) file of the Dafalias-Manzari model, compatible with FLAC3D Version 7.0 64-bit.

Note: Model DLL files may be loaded into *FLAC3D* while it is running by giving the command **ZONE CMODEL LOAD 'modeldafalias007.dll'**. DLL files will be automatically loaded if they are placed in the "exe64\plugins\model" folder (strongly recommend). Thereafter, the model name, **dafalias**, and property names will be recognized by *FLAC3D* and *FISH* functions that refer to the model and its properties. If the **ZONE CMODEL LOAD** command is given for a model that is already loaded, nothing will be done, but an informative message will be displayed. Before constitutive model plug-ins can be assigned to zones, the model must be configured for their use by giving the **MODEL CONFIGURE PLUGIN** command. Once so configured, the model will not cycle unless your *FLAC3D* license includes the C++ plug-in option.

Demonstration Examples

Single Zone DSS simulation	A cyclic loading example
Drained Triaxial Simulation	Example to validate the Toyoura Sand drained triaxial lab tests (Verdugo & Ishihara, 1996)
Undrained Triaxial Simulation	Example to validate the Toyoura Sand undrained triaxial lab tests (Verdugo & Ishihara, 1996)

Some simulated results are illustrated Figure 1 to Figure 5.

Contact information

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Disclaimer

It is subjected to the Itasca UDM Liability: https://www.itascacg.com/software/udm-library.

Referencies

Cheng, Z., Dafalias, Y.F. & Manzari, M.T. (2013). Application of SANISAND Dafalias-Manzari Model in *FLAC3D*. in *Continuum and Distinct Element Numerical Modeling in Geomechanics.* H. Zhu, C. Detournay, R. Hart, and M. Nelson, Eds. Minneapolis: Itasca International, Inc.

Dafalias, Y.F. & Manzari, M.T. (2004). Simple plasticity sand model accounting for fabric change effects. *Journal of Engineering Mechanics* 130(6): 622-634.

Verdugo, R. & Ishihara, K. (1996). The steady state of sand soils. *Soils and Foundation* 36(2): 81-92.

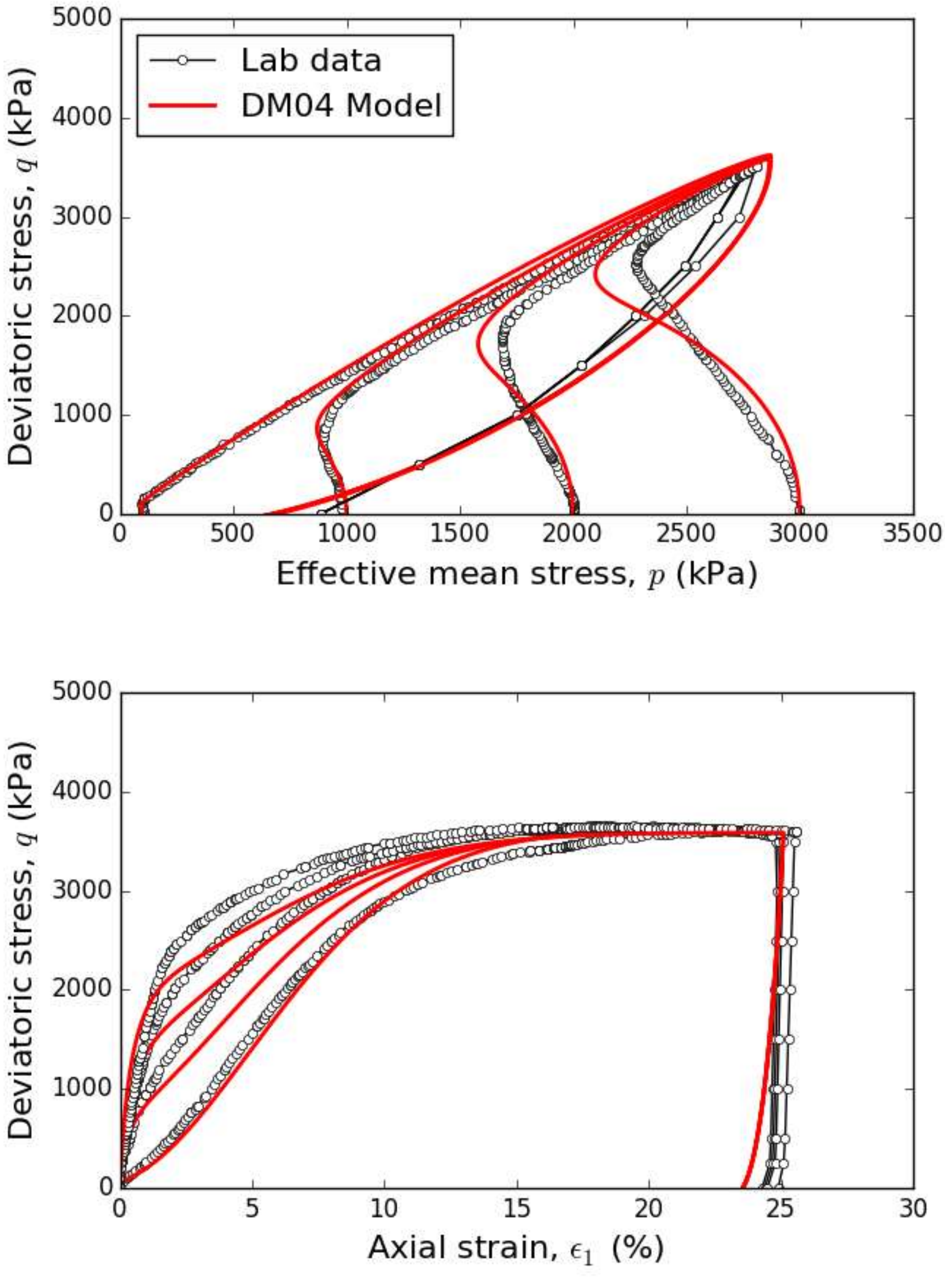

Figure 1: Simulated versus experiment in undrained trial compression tests e_0 = 0.735.

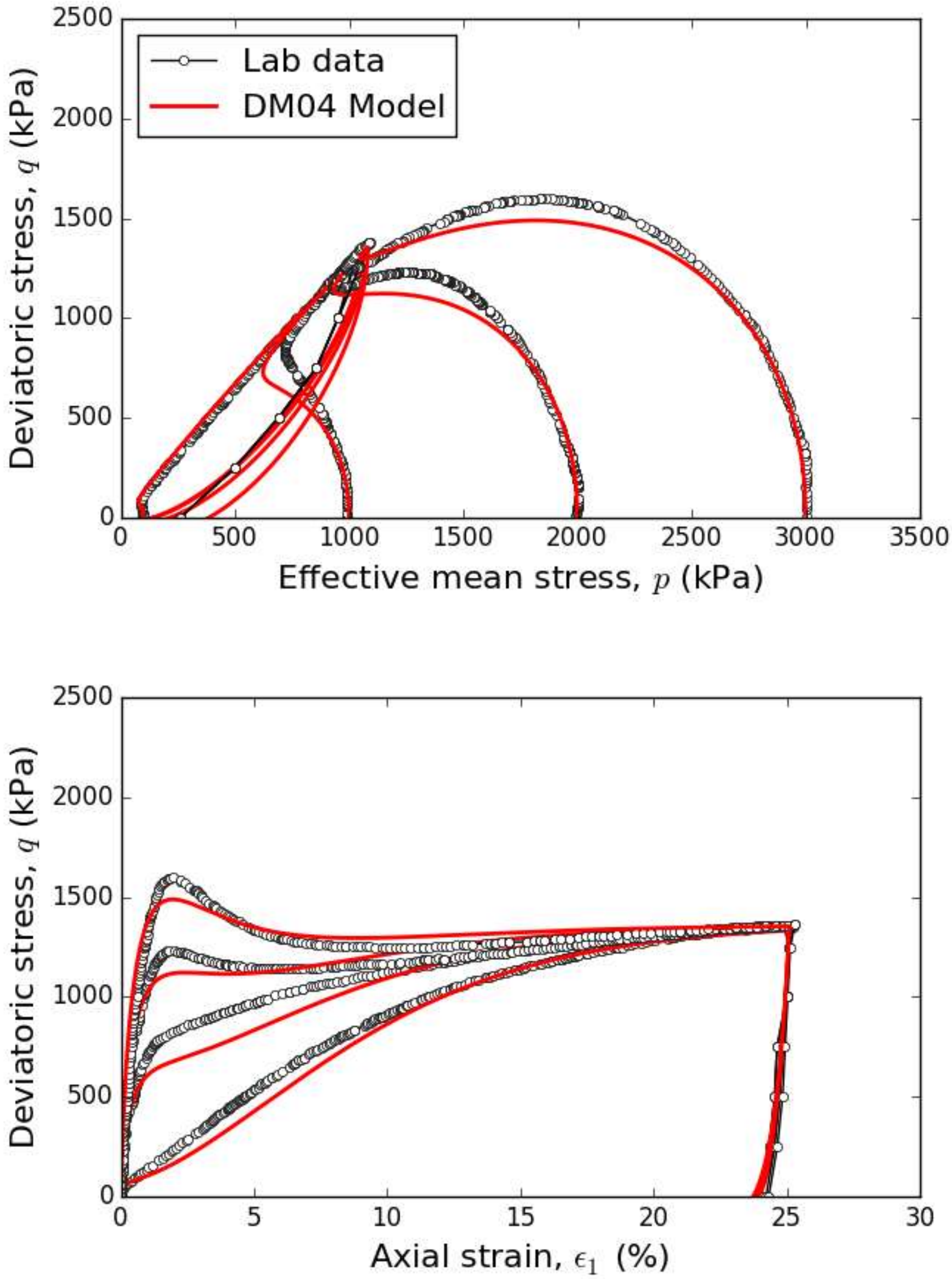

Figure 2: Simulated versus experiment in undrained trial compression tests e_0 = 0.833.

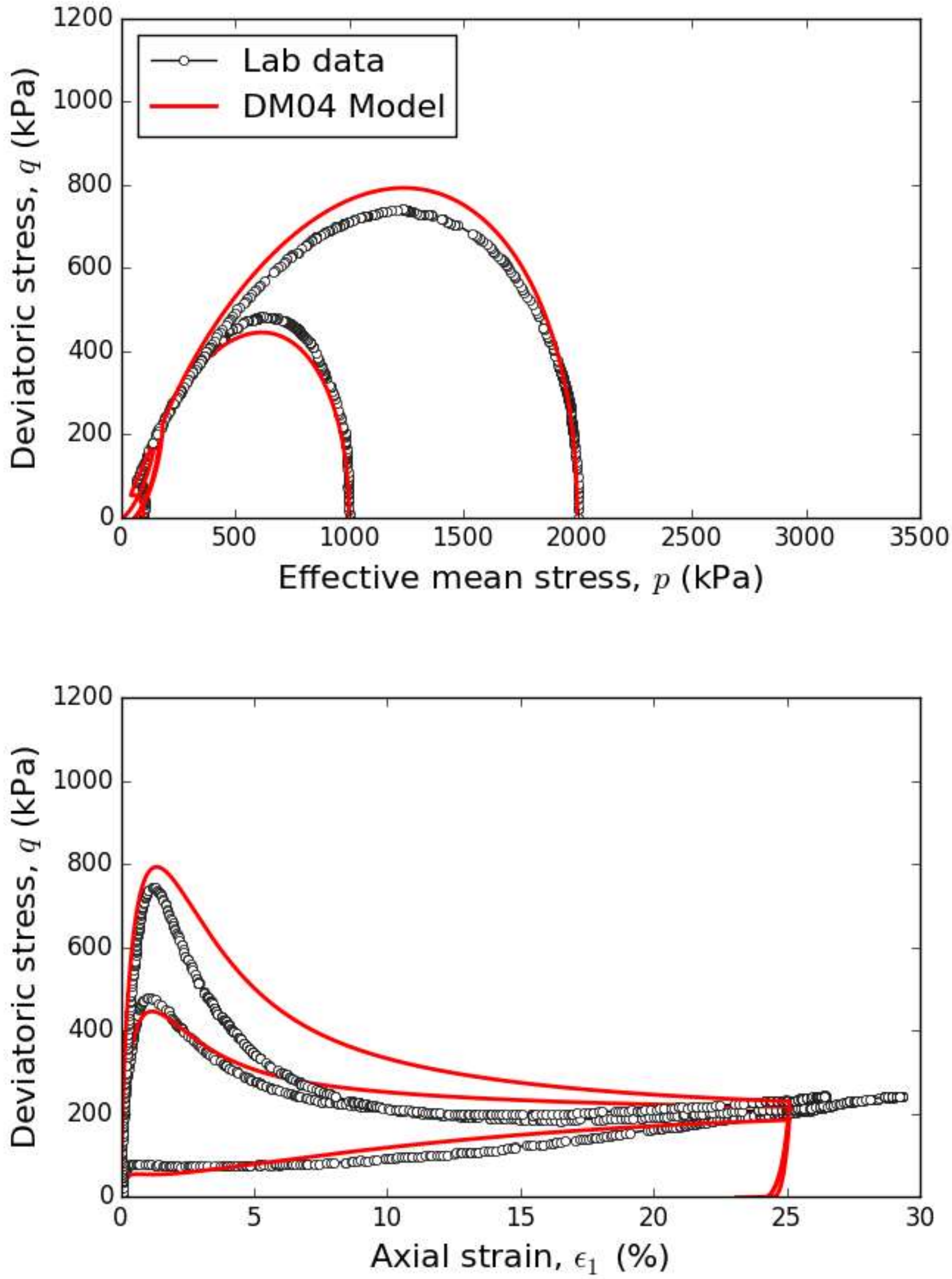

Figure 3: Simulated versus experiment in undrained trial compression tests e_0 = 0.907.

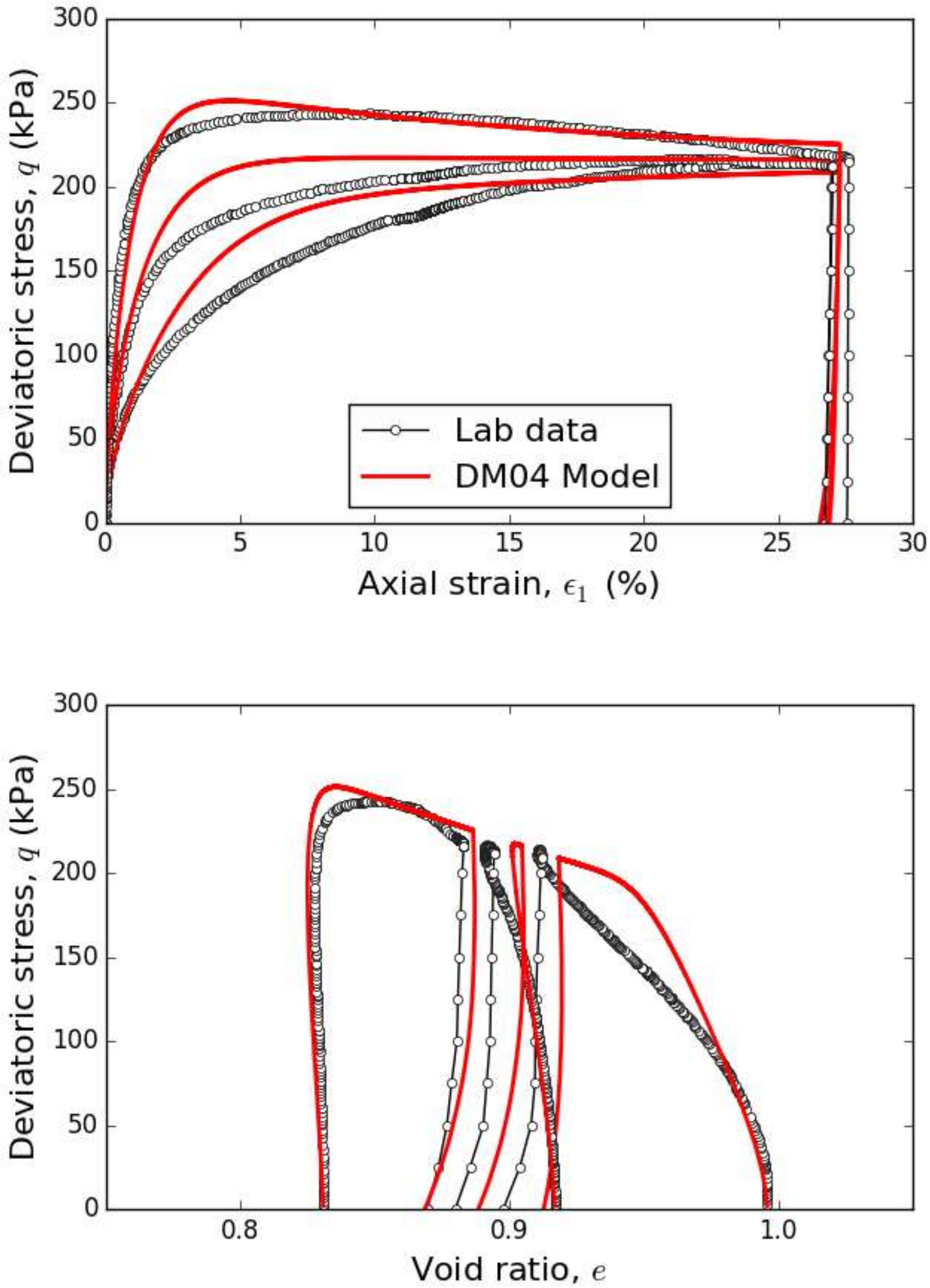

Figure 4: Simulated versus experiment in drained trial compression tests p_0 = 100 kPa.

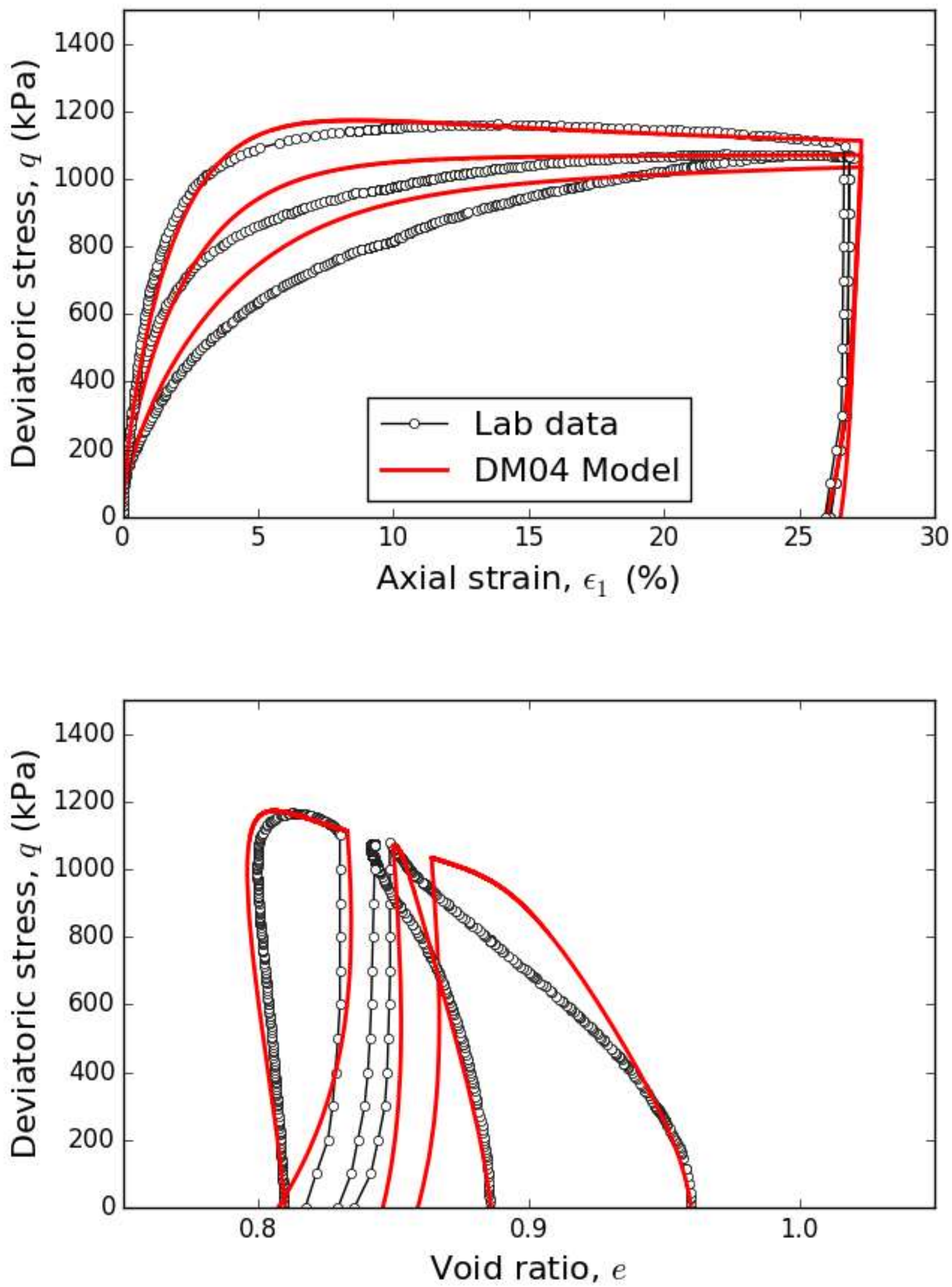

Figure 5: Simulated versus experiment in drained trial compression tests p_0 = 500 kPa.