Permanent deformation model for unbound granular materials

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Sorry – this is to difficult

- Thank you for your attention

Damages

- Elastic deformations (too little stiffness in unbound layers)
  - Fatigue cracking in asphalt
  - High stress in lower layers => permanent deformations
- Permanent deformations (too little resistance against)
  - Rutting

Observations from triaxial testing

- Changes in compaction, grading, water content …. Influences to some degree resilient modulus
- Changes in compaction, grading, water content …. Influences to very high degree resistance against permanent deformations
- No good correlations between elastic stiffness and resistance against permanent deformations

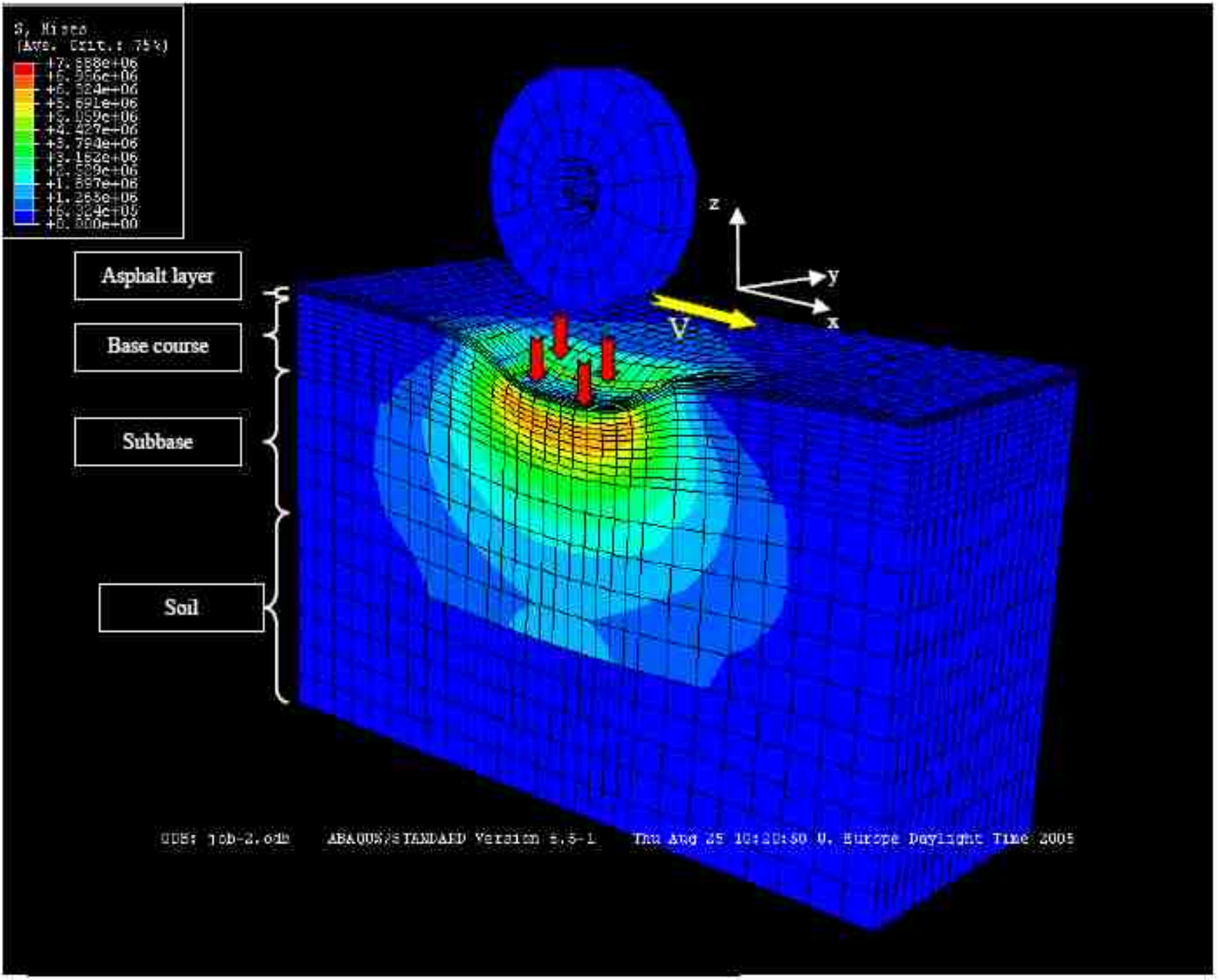
Elastic vs permanent deformations

- For a single axle: $\varepsilon_p << \varepsilon_d$
- For accumulated traffic: $\varepsilon_p > \varepsilon_d$
- For modelling purposes it is convenient to separat elastic and permanent deformation
- Elastic analysis => Stress situation => permanent deformation

Calculation of elastic stress

- Non-linear model important
- Horisontal stress important


DK 17802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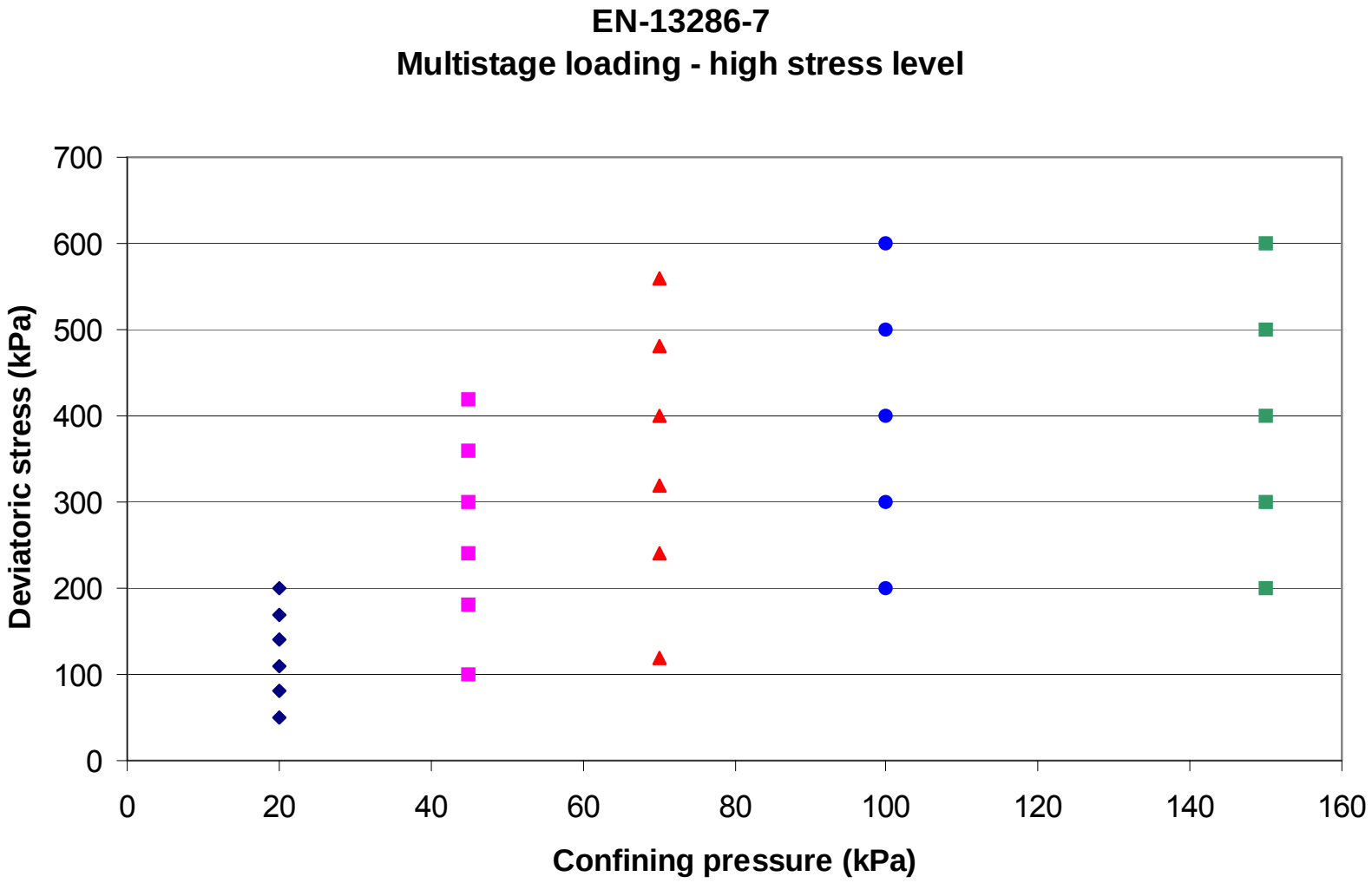
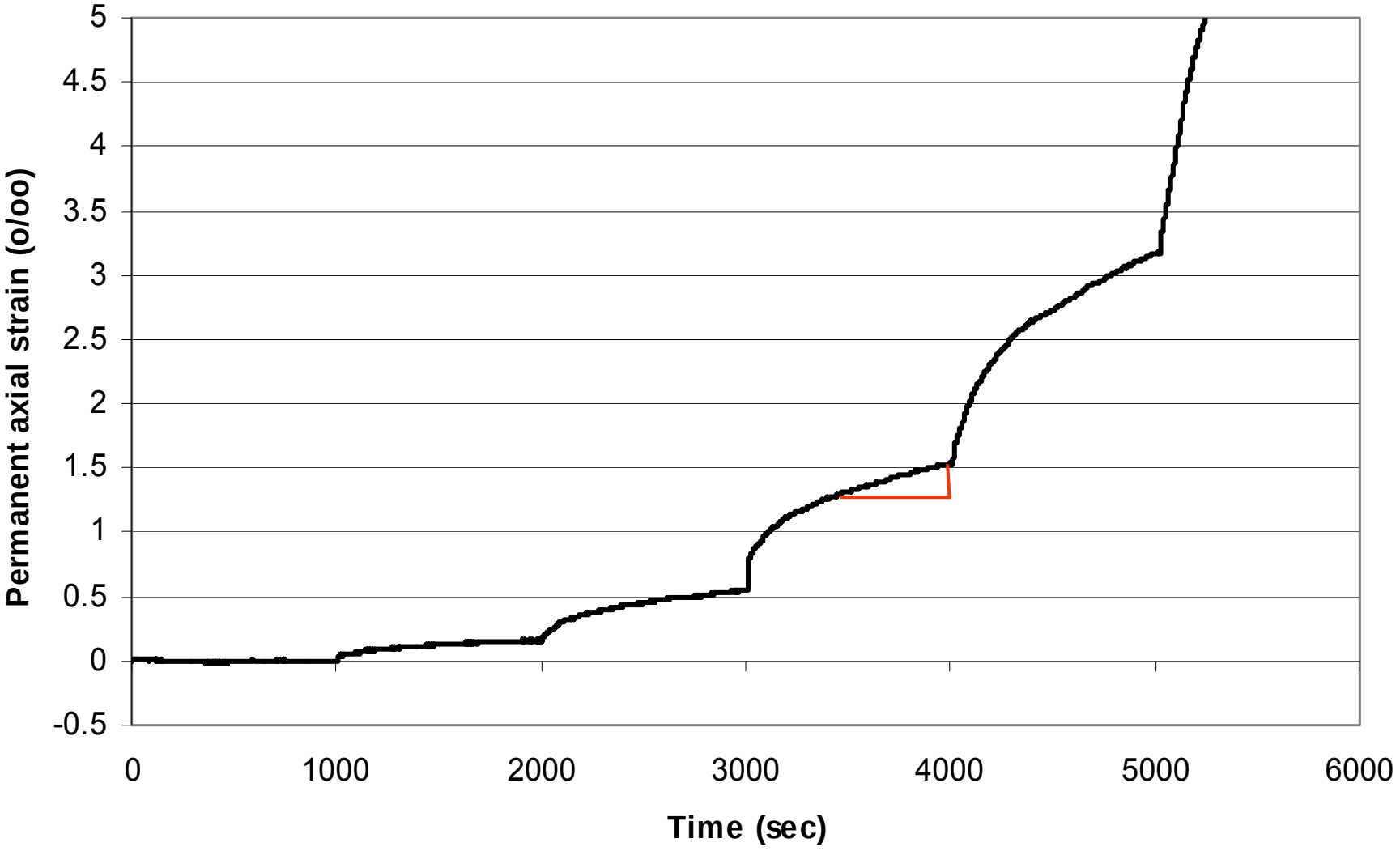
Asphalt layer
Base course
Subbase
Soil
z
y
x
V
ODB: job-2.odb ABAQUS/STANDARD Version 6.5-1 Thu Aug 25 10:20:50 U. Europe Daylight Time 2005

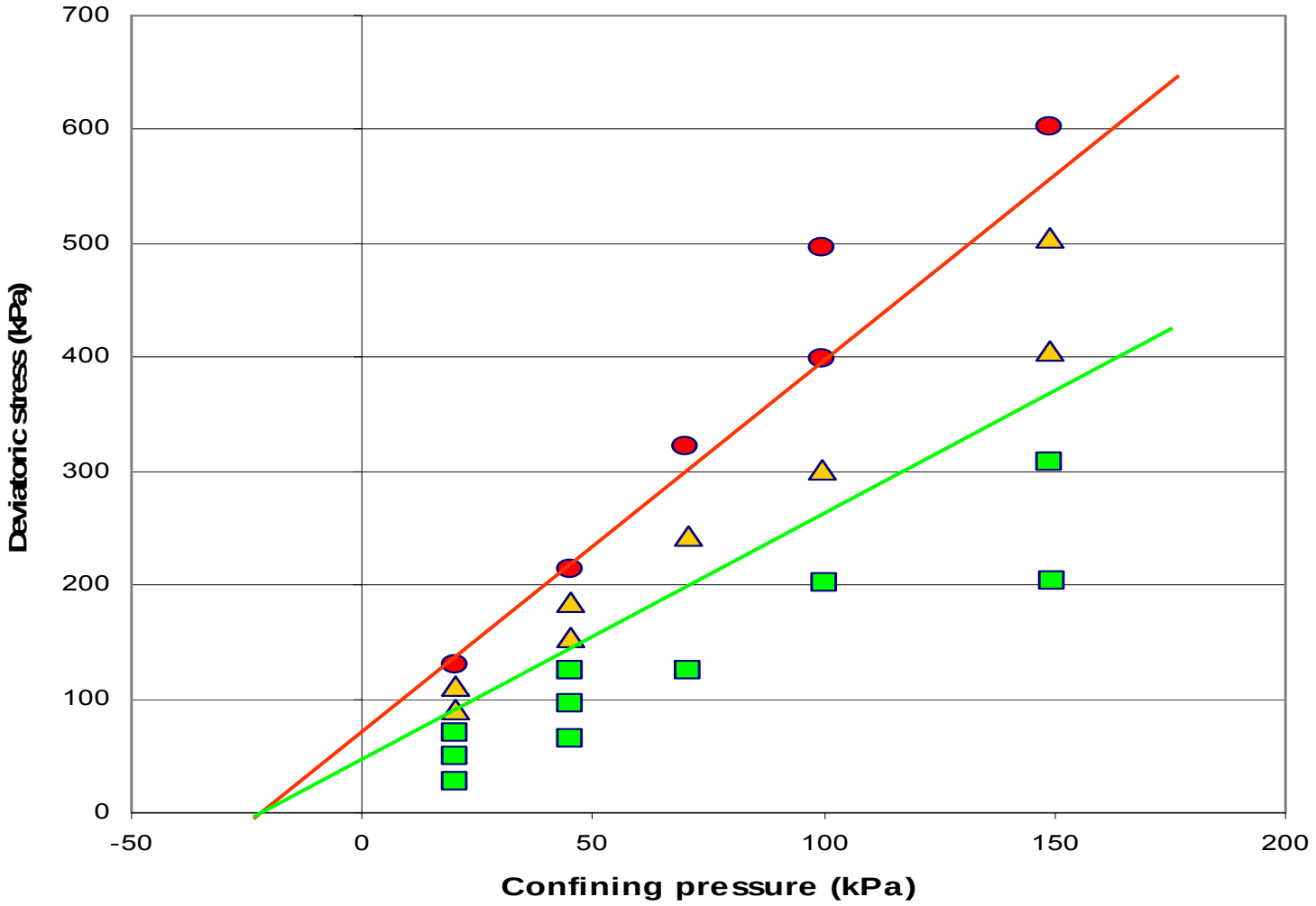
Loading procedure



Development of permanet deformations



Resistance against permanent deformations



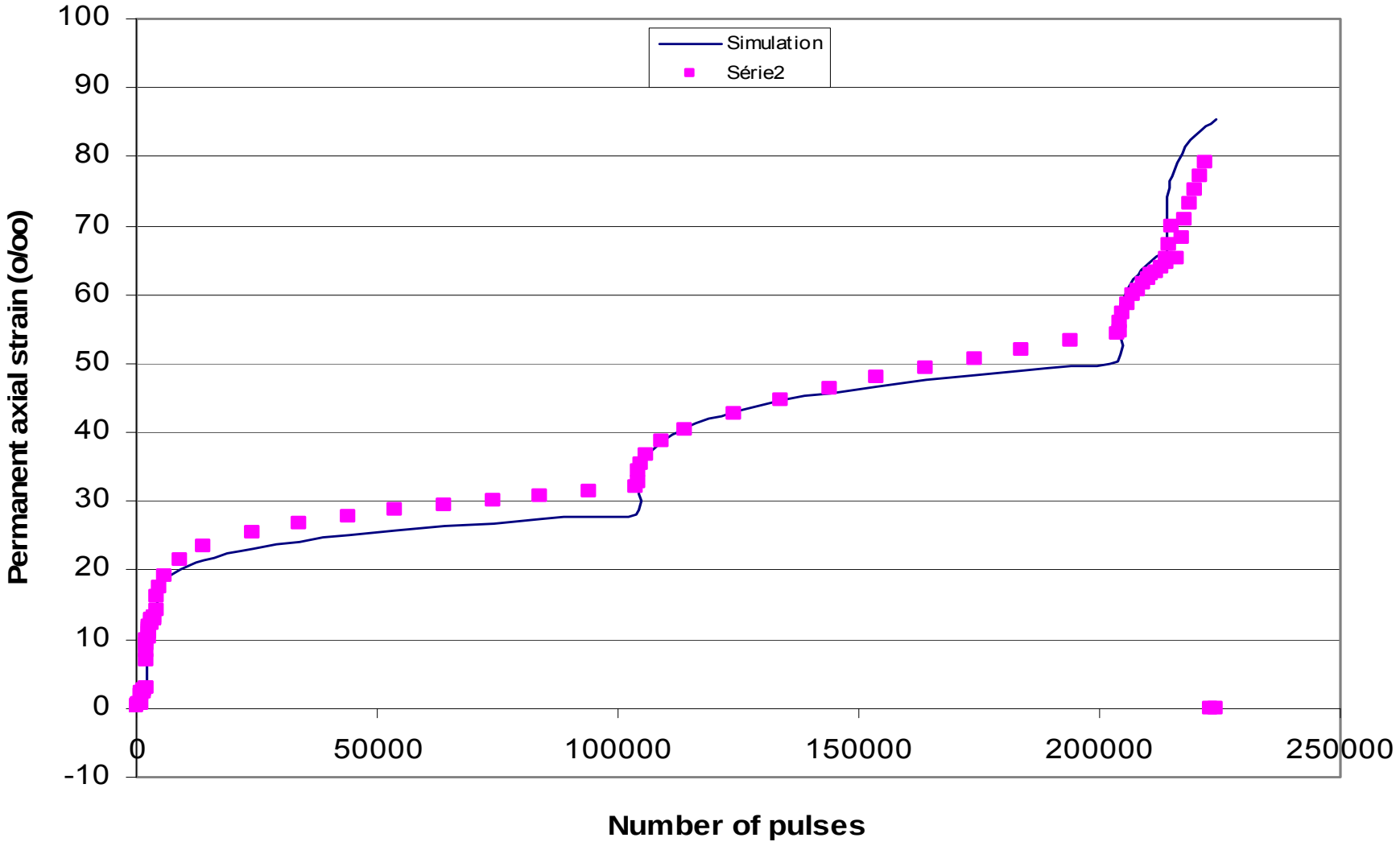
Next step – model for prediction

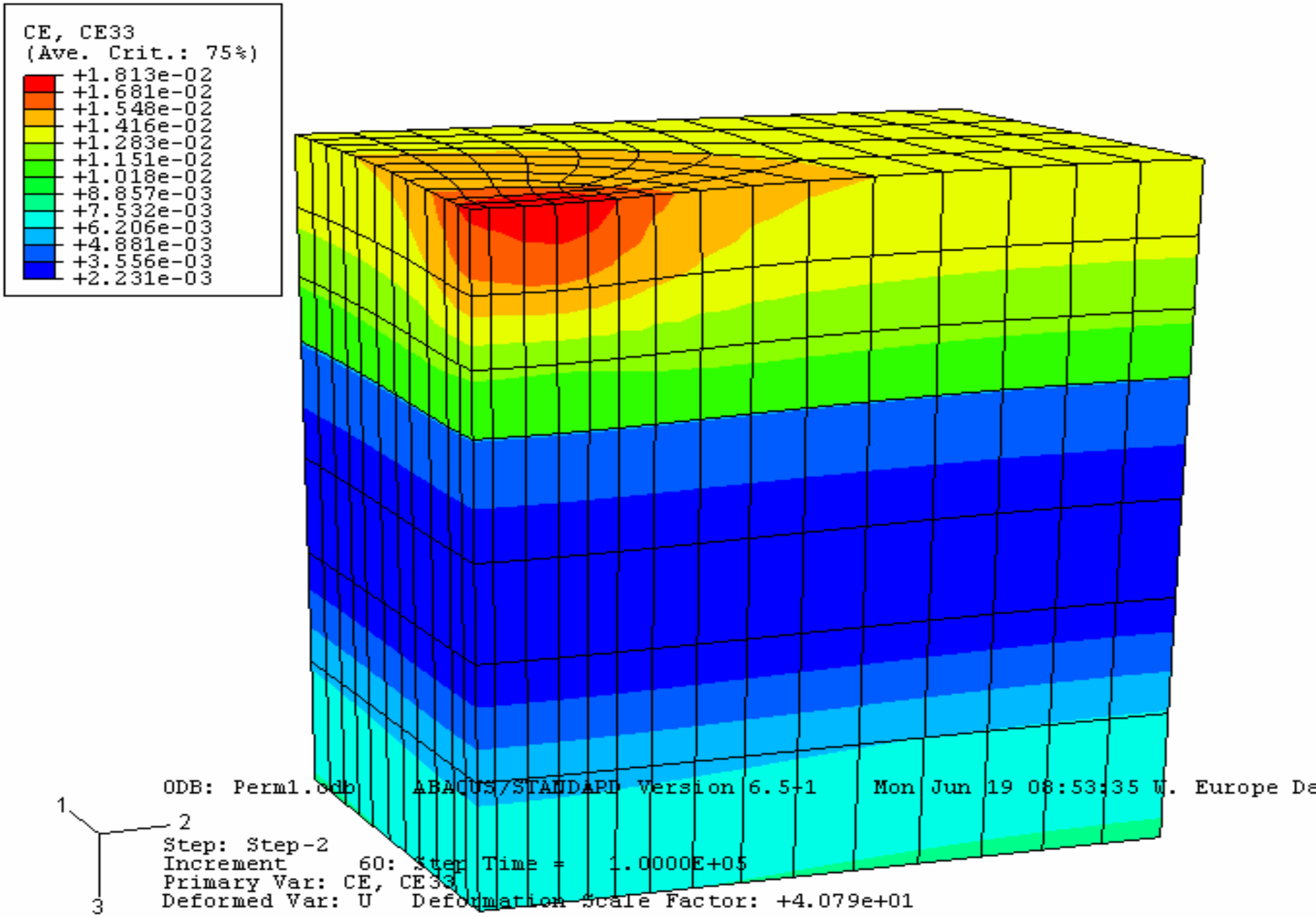
- Function of :
  - Traffic e.g. number of axels
  - Elastic stress in the layer
  - Material parameters to describe resistance against permanent deformations
- User defined material in ABAQUS
  - No need to build post- and pre- processing
  - Maintainance
  - Verification of the system it self

Model approch

- Extended Drucker-Prager model combined with a creep model

Fitting to triaxial tests




CE, CE33
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+1.681e-02
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+1.416e-02
+1.283e-02
+1.151e-02
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+8.857e-03
+7.532e-03
+6.206e-03
+4.881e-03
+3.556e-03
+2.231e-03
ODB: Perm1.odb ABAQUS/STANDARD Version 6.5-1 Mon Jun 19 08:53:35 W. Europe Da
1
2
3
Step: Step-2
Increment 60: Step Time = 1.0000E+05
Primary Var: CE, CE33
Deformed Var: U Deformation Scale Factor: +4.079e+01

Simulation of HVS test at VTI

	Base type 1	Base type 3
Measured	6.5	5.5
Modified HED	4.1	1.1-2.4

Limitations

- Laboratory testing
  - Not able to simulate stress rotation
  - Stress history important
- Inaccuracy in all part of the chain
- Field calibration necessary

Conclusions

- ABAQUS model working well
  - Two stage analysis: elastic => plastic
- Model seem to predict laboratory testing well
- Reasonable fit to a few field trials
- Easy to combine with models for other materials to a complete performance prediction tool