REPUBLIK INDONESIA
KEMENTERIAN HUKUM DAN HAK ASASI MANUSIA

SURAT PENCATATAN
CIPTAAN

Dalam rangka pelindungan ciptaan di bidang ilmu pengetahuan, seni dan sastra berdasarkan Undang-Undang Nomor 28 Tahun 2014 tentang Hak Cipta, dengan ini menerangkan:

Nomor dan tanggal permohonan	:	EC00202133543, 15 Juli 2021
Pencipta		
Nama	:	**Dr. techn. Indra Noer Hamdhan ST., MT. dan Rinaldi Alamsyah**
Alamat	:	Jl. Sariasih No. 63 RT/RW: 012/009 Sarijadi Sukasari , Bandung , JAWA BARAT, 40151
Kewarganegaraan	:	Indonesia
Pemegang Hak Cipta		
Nama	:	**LPPM Itenas**
Alamat	:	Jl. PHH. Mustafa No. 23 Bandung , Bandung , JAWA BARAT, 40124
Kewarganegaraan	:	Indonesia
Jenis Ciptaan	:	**Poster**
Judul Ciptaan	:	**2D Vs. 3D Model In Slope Stability Analysis Using The Finite Element Method**
Tanggal dan tempat diumumkan untuk pertama kali di wilayah Indonesia atau di luar wilayah Indonesia	:	15 Juli 2021, di Bandung
Jangka waktu pelindungan	:	Berlaku selama 50 (lima puluh) tahun sejak Ciptaan tersebut pertama kali dilakukan Pengumuman.
Nomor pencatatan	:	000260939

adalah benar berdasarkan keterangan yang diberikan oleh Pemohon.
Surat Pencatatan Hak Cipta atau produk Hak terkait ini sesuai dengan Pasal 72 Undang-Undang Nomor 28 Tahun 2014 tentang Hak Cipta.

a.n. MENTERI HUKUM DAN HAK ASASI MANUSIA
DIREKTUR JENDERAL KEKAYAAN INTELEKTUAL

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Pengajuan Hak Kekayaan Intelektual (HKI)

POSTER

2D vs. 3D Model in Slope Stability Analysis using the Finite Element Method

Oleh:
Indra Noer Hamdhan
Rinaldi Alamsyah

BANDUNG – JAWA BARAT - INDONESIA
2021

2D vs. 3D Model in Slope Stability Analysis using the Finite Element Method

Indra Noer Hamdhan
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Description

Three examples of slope stability analysis from Griffiths and Lane (1999) will be discussed. These examples are analyzed by finite element method using 2D model and will be compared with 3D model. The analysis was performed by utilizing PLAXIS 2D and PLAXIS 3D software. The soil model used in the analysis is the Mohr-Coulomb using very fine meshes with coarseness factor of 0.3536.

The main objective is to evaluate and to compare the safety factor of the slope between 2D model and 3D model using finite element method by assuming a Mohr-Coulomb failure criterion.

Homogeneous Slope with a Foundation Layer

The difference of factor of safety between 2D and 3D model is only 2.93% and the failure mechanism of these methods are similar.

An Undrained Clay Slope with a Thin Weak Layer

The analysis are carried out using a constant value of undrained shear strength of soil (c_{u1}) and five different values of undrained shear strength of the thin layer (c_{u2}) with ratio c_{u2}/c_{u1} equal to 1, 0.8, 0.6, 0.4, and 0.2.

The average difference of the safety factors between 2D and 3D model with the ratio $cu2/cu1 < 0.6$ is 17.4%. This ratio is quite significant. The slip surface will occur on the thin weak layer. However, with the ratio $cu2/cu1 \geq 0.6$, there is no significant difference of the safety factors between 2D and 3D model. The ratio is only 3.0% and the slip surface is base failure mechanism.

Homogeneous Slope with Horizontal Free Surface

In this analysis, a slope with different drawdown ratio, L/H which has been varied from 0.0 (slope completely submerged with water level at the crest of the slope) to 1.0 (water level at the toe of the slope) were considered.

The average difference of factor of safety between 2D model and 3D model is only 1.6% and the failure mechanisms of both models are similar.

Summary
It is generally thought that 2D model will produce more conservative the safety factors. The factor of safety from 3D model are higher than 2D model. The main reason for the differences is the ability of 3D model to account for the three-dimensional nature of the various model inputs, including the slope geometry, the distribution of soil domains, the orientation of the insitu stresses, and the distribution of pore pressure.

2D vs. 3D Model in Slope Stability Analysis using the Finite Element Method

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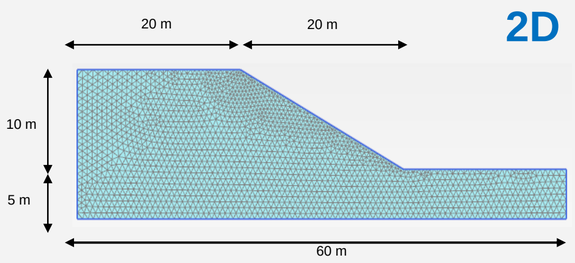
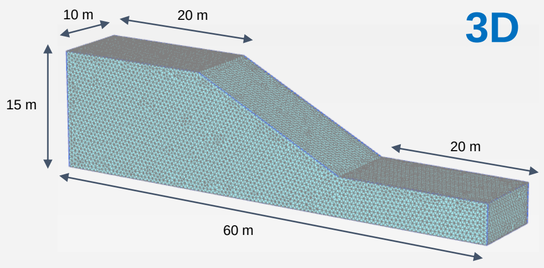
*Three examples of slope stability analysis from Griffiths and Lane (1999) will be discussed. These examples are analyzed by finite element method using 2D model and will be compared with 3D model. The analysis was performed by utilizing **PLAXIS 2D** and **PLAXIS 3D** software. The soil model used in the analysis is the Mohr-Coulomb using very fine meshes with coarseness factor of 0.3536.*

Homogeneous slope with a foundation layer

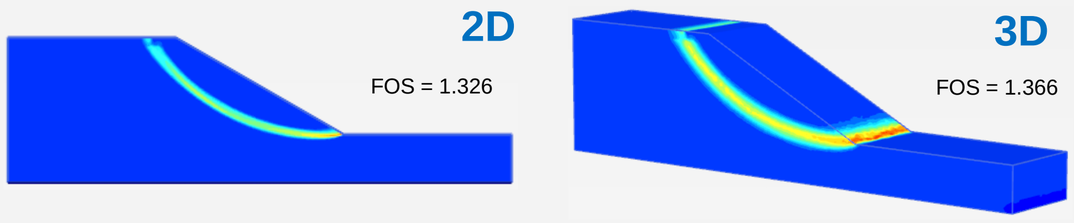
Geometry and mesh for a homogeneous slope with a foundation layer

Unit Weight: 20 kN/m³
c' = 10 kPa, ϕ'= 20°
ν = 0.3, E': 100.000 kPa





Failure mechanism for a homogeneous slope with a foundation layer using 2D and 3D model:

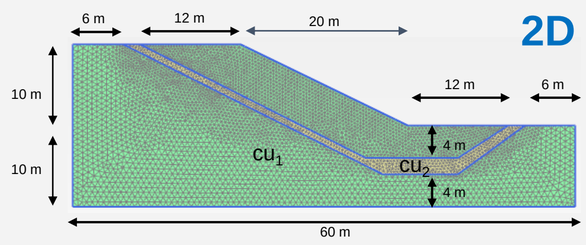


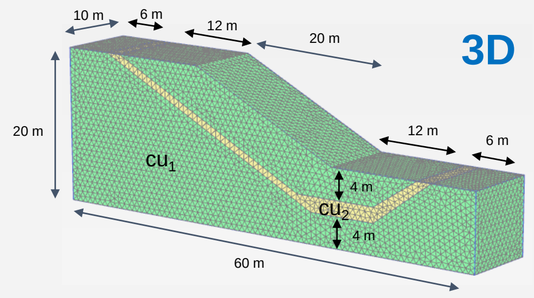
The difference of factor of safety between 2D and 3D model is only 2.93% and the failure mechanism of these methods are similar.

An undrained clay slope with a thin weak layer

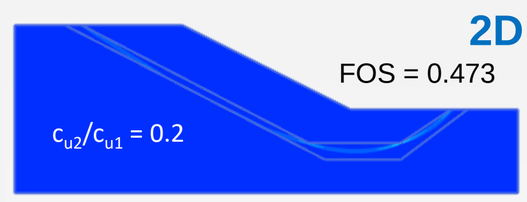
Geometry and mesh for an undrained clay slope with a thin weak layer

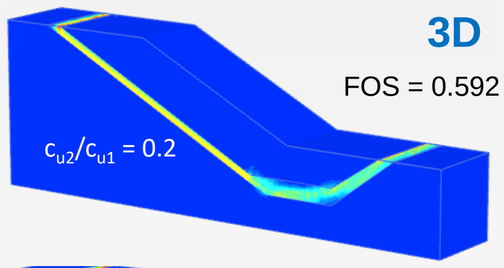
Unit Weight: 20 kN/m³
c_{u1} = 50 kPa, ϕ_u= 0°
ν = 0.3, E': 100.000 kPa

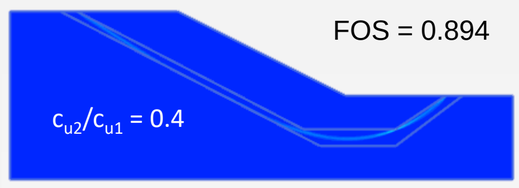


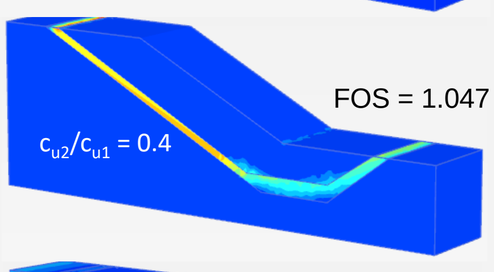


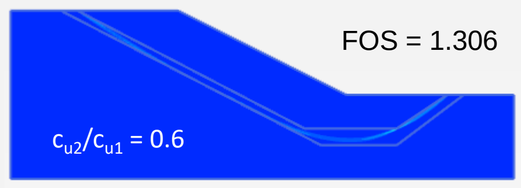
The analysis are carried out using a constant value of undrained shear strength of soil (c_{u1}) and five different values of undrained shear strength of the thin layer (c_{u2}) with ratio cu2/cu1 equal to 1, 0.8, 0.6, 0.4, and 0.2. Failure mechanism for an undrained clay slope with a thin weak layer using 2D model and 3D model:

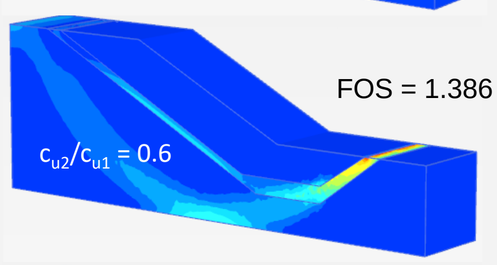


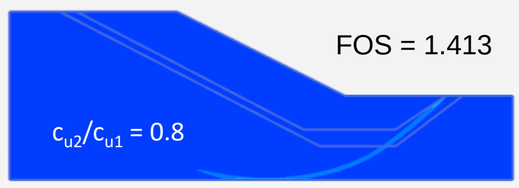


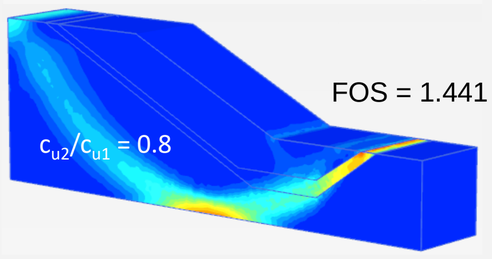


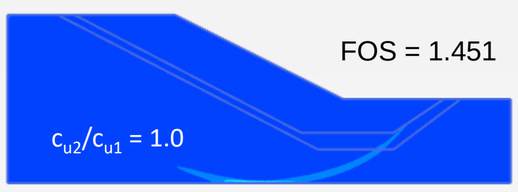


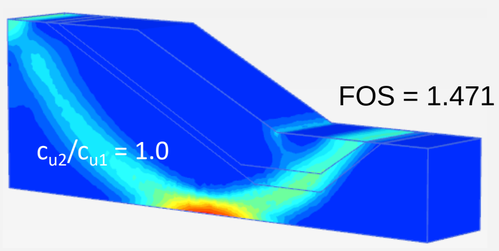












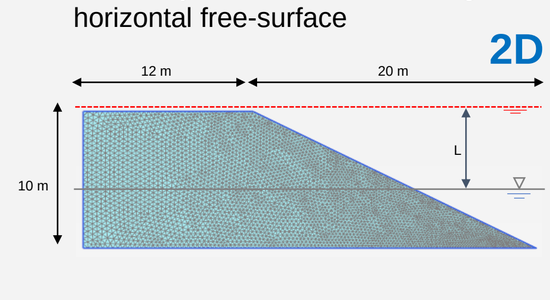
c_{u2}/c_{u1}	2D Model	3D Model
0.2	0.473	0.592
0.4	0.894	1.047
0.6	1.306	1.386
0.8	1.413	1.441
1.0	1.451	1.471

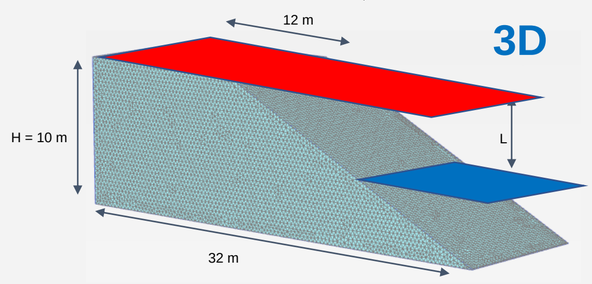
The average difference of the safety factors between 2D and 3D model with the ratio c_{u2}/c_{u1} < 0.6 is 17.4%. This ratio is quite significant. The slip surface will occur on the thin weak layer. However, with the ratio cu2/cu1 ≥ 0.6, there is no significant difference of the safety factors between 2D and 3D model. The ratio is only 3.0% and the slip surface is base failure mechanism.

Homogeneous slope with horizontal free surface

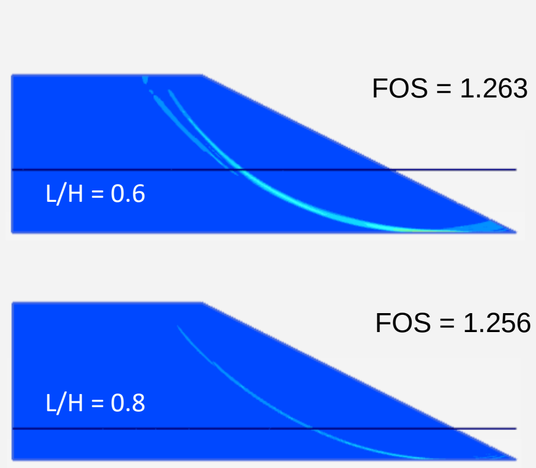
Geometry and mesh for a homogeneous slope with horizontal free-surface

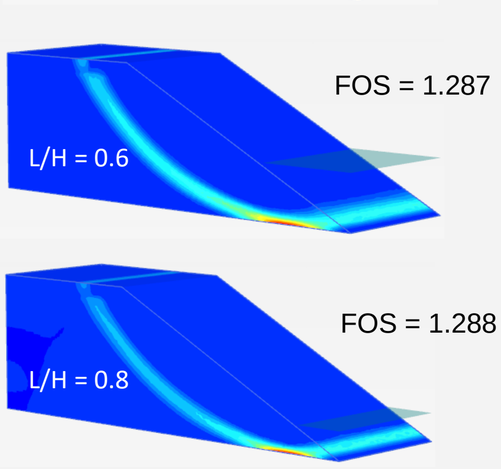
Unit Weight: 20 kN/m³
c' = 10 kPa, ϕ'= 20°
ν = 0.3, E': 100.000 kPa

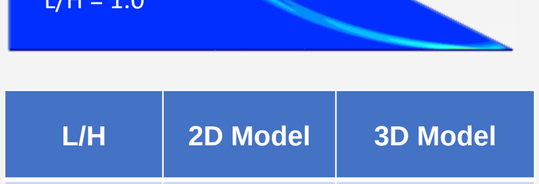


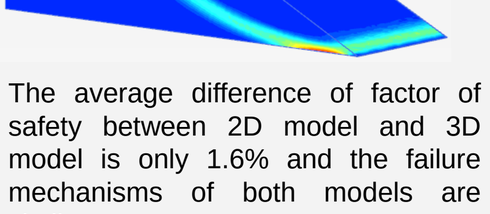


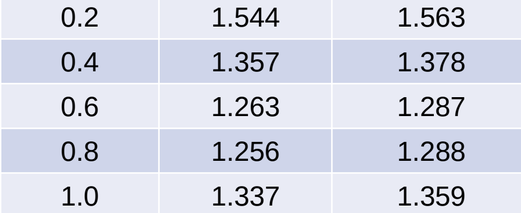
In this analysis, a slope with different drawdown ratio, L/H which has been varied from 0.0 (slope completely submerged with water level at the crest of the slope) to 1.0 (water level at the toe of the slope) were considered. Failure mechanism for a homogeneous slope with horizontal free-surface using 2D model and 3D model:

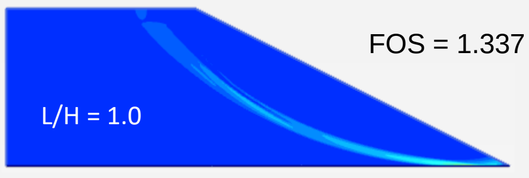


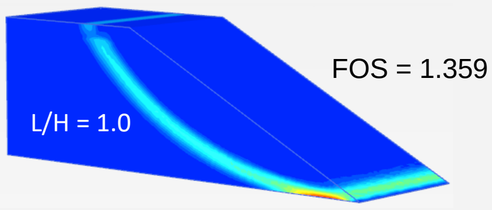












L/H	2D Model	3D Model
0.0	1.802	1.821
0.2	1.544	1.563
0.4	1.357	1.378
0.6	1.263	1.287
0.8	1.256	1.288
1.0	1.337	1.359

The average difference of factor of safety between 2D model and 3D model is only 1.6% and the failure mechanisms of both models are similar.

Summary

It is generally thought that 2D model will produce more conservative the safety factors. The factor of safety from 3D model are higher than 2D model. The main reason for the differences is the ability of 3D model to account for the three-dimensional nature of the various model inputs, including the slope geometry, the distribution of soil domains, the orientation of the insitu stresses, and the distribution of pore pressure.