
Optum Computational Engineering
Optum G2
optimal solutions for geotechnical analysis
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Complete geotechnical deformation and stability analysis

OptumG2 is a comprehensive finite element program for geotechnical stability and deformation analysis in plane strain or axisymmetry. Its modern graphical user interface ensures an intuitive and efficient workflow. The computational core builds on state-of-the-art numerical algorithms that lead to an unprecedented efficiency and robustness – independent of the complexity of the model.

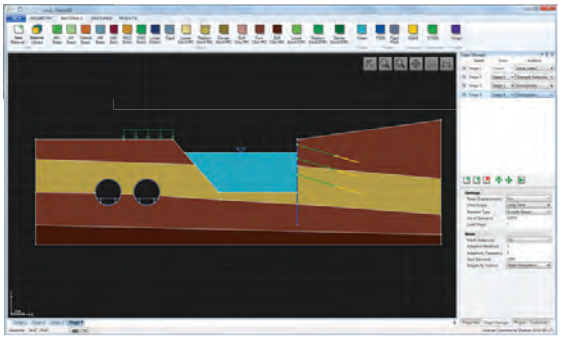
What makes OptumG2 different?

OptumG2 is a finite element program designed specifically for geotechnical applications. While it shares some features with conventional finite element programs it also differs in a number of key aspects, including:

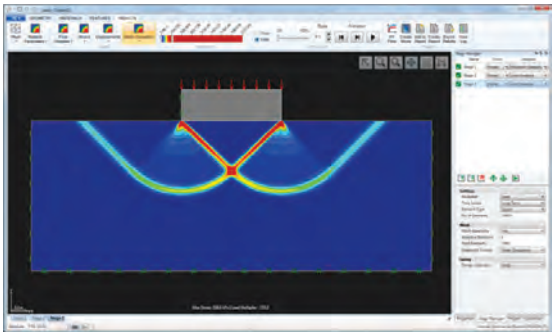
+ **Robustness and efficiency:** The computational core of OptumG2 builds on state-of-the-art numerical algorithms that mark a radical departure from traditional approaches. These algorithms lead to a level of robustness and efficiency unmatched by any existing programs for geotechnical finite element analysis. Failure to converge and similar "numerical problems" that continue to haunt conventional finite element programs are non-issues in OptumG2. As such, tedious and time consuming tweaking of algorithmic parameters is unnecessary and all attention can be devoted to what it is all about, namely the physics of a given problem.

+ **Direct answers to direct questions:** OptumG2 provides a range of analysis types designed specifically to provide direct answers to direct questions without having to go through lengthy and superfluous analyses. An example is Limit Analysis which allows for a rapid assessment of the bearing capacity of geostructures without having to go through a time consuming incremental elastoplastic analysis. On the other hand, if the full load-displacement curve is needed this can be computed as well. The ability to provide the most direct answer to a given question makes OptumG2 ideal for design – in contrast to conventional finite element programs which are geared primarily for analysis.

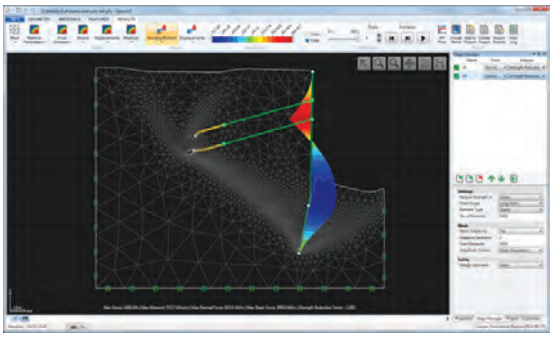
+ **Upper and lower bounds:** Conventional finite element programs provide approximate solutions, be it to the settlement of a foundation or the factor of safety of a slope. While the solutions are usually on the unsafe side they may also be on the safe side though, in either case, there is no way of knowing by how much. Consequently, the process of gradually refining the mesh is seen as a standard part of any finite element analysis. OptumG2 offers an alternative to this lengthy (and often inconclusive) process by enabling the computation of rigorous upper and lower bounds to quantities of interest (displacements, bearing capacity, factor of safety, etc). With such bounds available, an estimate of the exact solution *and* a measure of the worst-case error are immediately available, both of which may be improved by using more elements. Furthermore, for design purposes lower bound solutions on bearing capacity and factor of safety are always on the safe side and may hence be used directly to obtain a safe design.



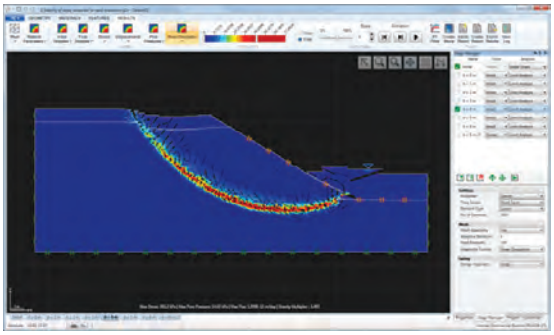
Modern Graphical User Interface ensuring an intuitive and efficient workflow



Limit Analysis for rapid and rigorous evaluation of upper and lower bounds on bearing capacity



Staged Construction for excavation analysis, embankment construction, tunnelling, etc



Strength Reduction Analysis for rapid and rigorous evaluation of upper and lower bounds on factor of safety

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What makes OptumG2 different? (continued)

+ Automatic adaptive mesh refinement: As a standard part of all analyses, it is possible to use automatic adaptive mesh refinement. The idea is to first compute a solution using a more or less uniform mesh and then gradually, in the course of a number of iterations specified by the user, improve on this mesh to capture the solution in the best possible way. Combined with ability to compute upper and lower bounds on quantities of interest, adaptive mesh refinement provides a powerful means of maximizing accuracy while keeping the computational cost at a minimum. This feature is not available in any existing packages for geotechnical finite element analysis.

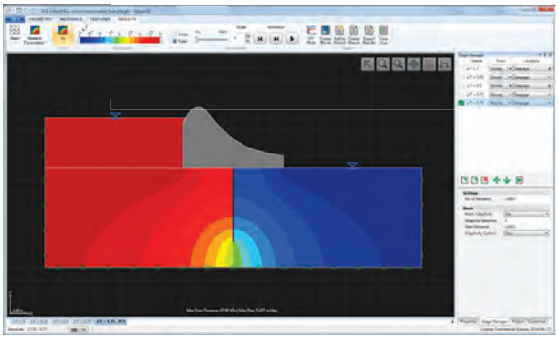
+ Integrated analysis types: Most geotechnical analyses require several independent analyses. For example, to determine the settlements of a foundation subjected to working loads, the initial pore pressures and stresses first need to be determined before the main analysis can proceed. In OptumG2, such preliminary analyses are carried out automatically as part of the main analysis (though with the possibility of defining all stages manually).

+ Eurocode 7 compatibility: The analysis types available in OptumG2 are very well aligned with the philosophy of Eurocode 7. ULS can be handled via Limit Analysis and Strength Reduction while SLS is handled via Elastoplastic or Consolidation analysis. Furthermore, OptumG2 includes functionalities for applying partial factors according to the various design approaches prescribed by Eurocode 7.

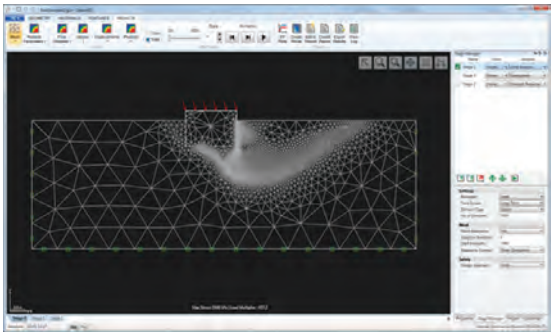
+ Modern graphical user interface: The graphical user interface of OptumG2 has been designed to ensure maximum efficiency in defining problems and interpreting results. Coupled with a computational core that poses very few limitations, the result is a user interface that is easy and intuitive to use – both for simple problems as well as for problems involving numerous construction stages, materials, and analysis types.

+ Stochastic analysis: To account for the inherent uncertainty and variability of the material parameters describing the strength and deformation properties of geomaterials, OptumG2 comes with the possibility to conduct stochastic analysis on the basis of the random fields concept. Random distributions of a specified parameter – given in terms of mean value, standard deviation and correlation lengths – are here generated and the analysis is carried out in a Monte Carlo fashion. Rather than a single value of settlement, bearing capacity or similar, the end result is probabilty distributions of these quantities. Alternatively, stochastic analyis may be conducted by importing distributions of parameters generated outside OptumG2.

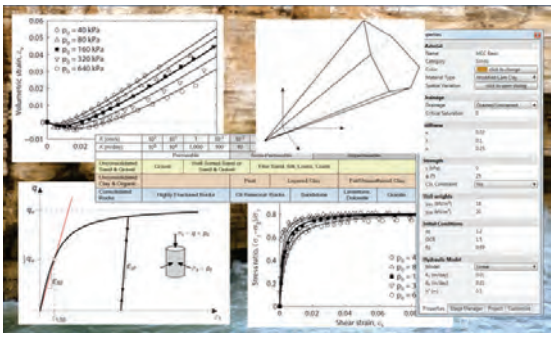
+ Command line version: While most problems are conveniently dealt with using the standard version of OptumG2, it is possible to bypass the graphical user interface and call the computational core from a command prompt or via batch files. This feature is useful when numerous similar problems need to be processed, for example in connection with parameter studies.



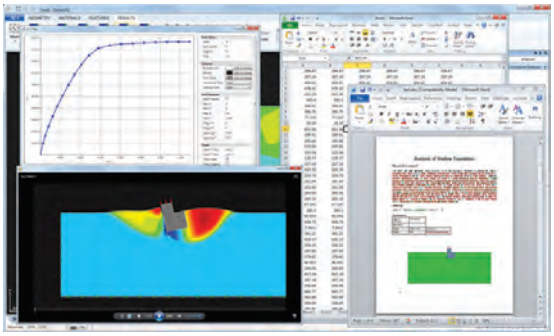
Seepage Analysis based on general variably saturated flow theory



Automatic adaptive mesh refinement ensuing maximum accuracy at minimum computational cost



Soil and Rock Models including Mohr-Coulomb, Tresca (Stanard & Generalized), Hoek-Brown, Modified Cam Clay, GSK, HMC, AUS and Bolton



Documentation Tools including plotting, videos, automatic report generation (MS Word) and results export (MS Excel)

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Soil and Rock Models

+ **Mohr-Coulomb:** the classic benchmark model with numerous enhancements including tension cut-off and fissures
+ **Drucker-Prager:** similar to but sometimes preferred over Mohr-Coulomb for rock and concrete
+ **Tresca:** Standard (isotropic) and Generalized (anisotropic) versions, the latter being relevant for axisymmetric analysis
+ **AUS:** Anisotropic Undrained Shear model for advanced analysis of soft soils displaying anisotropic strength and stiffness
+ **Hoek-Brown:** State-of-the-art model for fractured rock masses with various enhancements including compression cap
+ **GSK:** Useful and convenient nonlinear Mohr-Coulomb type model for geomaterials including rock, clay and sands
+ **Bolton:** State-of-the-art model for sands particularly relevant at low stress levels
+ **Modified Cam Clay:** The classic models for clays with various enhancements
+ **HMC:** Accurate and user friendly model for hardening soils including sands and stiff clay
+ **Hydraulic Models:** Various hydralic models, applicable to all materials, including the van Genuchten model

Analysis Types

+ **Limit Analysis:** Fast and rigorous evaluation of upper and lower bounds on bearing capacity, stability numbers, etc
+ **Strength Reduction:** Fast and rigorous evaluation of upper and lower bounds on factor of safety
+ **Elastoplastic:** Fast and accurate analysis using a variety of basic and advanced constitutive models
+ **Consolidation:** For analysis of time dependent excess pore pressure dissipation using a general Biot formulation
+ **Seepage:** Based on general variably saturated flow theory
+ **Initial Stress:** Determination of initial stresses on the basis of a specified earth pressure coefficient (arbitrary geometries)
+ **Staged Construction:** convenient and intuitive sequencing of construction stages

Structural Elements

+ **Plate:** Elastoplastic plates, possibly with elastoplastic hinges, for modelling walls, tunnel linings, foundation skirts, etc
+ **Geogrid:** For modelling geotextiles, soil nails and other types of reinforcement
+ **Fixed End Anchor:** Convenient element for modelling anchors as a point element
+ **Connector:** Element for Plate-to-Plate connections and similar without interacting with the soil
+ **Shear Joint:** For modelling discontinuities, faults, and similar features

Features

+ **Efficient and Robust Algorithms:** State-of-the-art algorithms ensure umatched efficiency and robustness
+ **Adaptive Mesh Refinement:** For all analysis – maximizes accuracy while minimizing computational time
+ **Upper and Lower Bounds:** Rigorous bounds on quantities of interest including bearing capacities and displacements
+ **Stochastic Analysis:** Random field simulation to determine probability distributions for quantities of interest
+ **Material Parameter Distributions:** Convenient import of user generated material parameter distributions
+ **Eurocode 7 Compatibility:** Functionality for applying partial factors according to Eurocode 7
+ **Command line version:** Bypass the graphical user interface and call the computational core via command prompt
+ **CAD Import:** Functionality for importing geometry in DXF format

Fully Supported

Whether you are in need of technical advice or assistance with your model, our support team are on hand to offer expert advice on all aspects of the software.

Download & Try

Visit www.optumce.com to download your copy of the latest version of OptumG2 and try it free for 30 days

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Новые средства для оценки деформации и стабильности геотехнических сооружений.

Андрей Лямин, Кристиан Краббенхофт и Йорген Краббенхофт

Optum Computational Engineering

АННОТАЦИЯ

Конечно-элементный расчет конструкций на предельные нагрузки уже давно был признан мощным инструментом для оценки стабильности различных геотехнических объектов, таких как основания и фундаменты, естественные и укрепленные склоны, подпорные стены, туннели и т.д. Разработанные главным образом в рамках научного сообщества, численные методы оценки предельного состояния сейчас достигли такого уровня зрелости, где их применение в геотехнической инженерной практике является не только возможным, но и связано с многочисленными преимуществами над более традиционными методами расчета.

Хотя расчет на предельные нагрузки и является важным аспектом геотехнического анализа и проектирования, оценка деформации при рабочих нагрузках представляет не менее актуальную задачу. Традиционно это производится с помощью обычных методов упруго-пластического моделирования. Однако оценка деформаций может быть также выполнена, используя те же численные технологии, что и для расчета на предельную нагрузку. Результатом является расчетная платформа, которая воплощает в себе лучшее из обоих подходов: гибкость и общность обычных методов упруго-пластического анализа и надежность и эффективность методов расчета на предельное состояние.

Недавно были предприняты усилия для воплощения этих численных технологий в форму, в которой они могут быть использованы практикующими инженерами на регулярной основе. В результате, специалистам предлагается новое программное обеспечение, которое охватывает большинство типов рачетов, необходимых для геотехнического проектирования, включая рачеты на предельную нагрузку, режимов фильтрации, упруго-пластической деформации, коэффициента надежности и поэтапного строительства. Кроме того, программа предлагает ряд нововведений, которые обеспечивают непревзойденную надежность и удобство пользования, по сравнению с типичными конечно-элементными пакетами.

Презентация охватывает теоретическую базу и основные аспекты нового программного продукта и демонстрирует примеры его использования при типичных геотехнических расчетах на упруго-пластическую деформацию и предельные нагрузки.

ДОКЛАДЧИК

Андрей Вадимович Лямин закончил Московский Физико-Технический Институт в 1985 и в 1994 году присоединился к группе геотехнических исследований в университете города Ньюкасл (Австралия), где в 2000 году защитил диссертацию на тему «Расчет предельных нагрузок 3-х мерных кострукций с использованием оценки снизу». В данный момент занимает должность профессора и лидера группы в недавно созданном научном центре геотехнических наук и инженерии в университете города Ньюкасл.