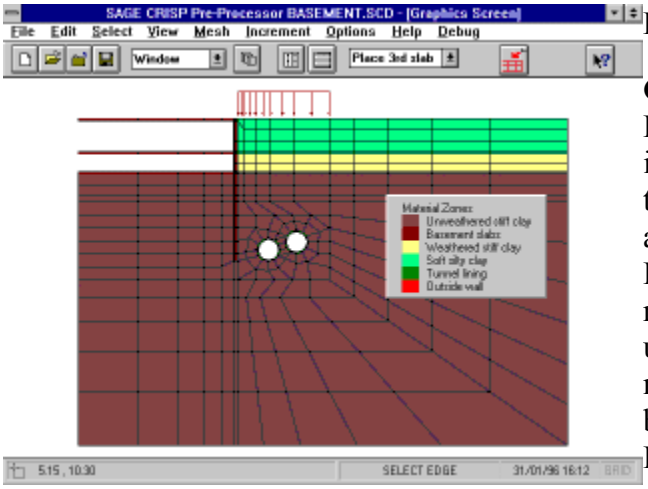
# Overview of SAGE CRISP®

**SAGE CRISP® 3-D** is now available. The 3-D product also supports 2-D modeling and analysis, but the original 2-D product is still available and supported for the benefit of users who need a more economical 2-D product or who prefer the traditional **SAGE CRISP® 2-D** interface. These **SAGE CRISP®** products, which run under MS Windows® 98, ME, NT 4 and 2000, combine the impressive analysis capabilities of **CRISP®** with modern, user-friendly graphical interfaces. The products include Pre- and Post-Processing Graphical User Interfaces (GUIs), the finite element analysis program and utilities for reporting data. **SAGE CRISP® .** The GUI's offer an intuitive, interactive environment in which models can be quickly and easily created and viewed. Post-processing operates in a similar environment, incorporating interactive data retrieval and results visualization. **CRISP®** has been extensively used worldwide by both the research and the industrial communities for many geotechnical problems, including retaining structures, embankments, tunnels and foundations. It has also been used in the analysis of footings, pile foundations, geo-textile reinforcement, soil nailing, effect of anisotropy, slope stability, bore hole stability and construction sequence studies.

*Example Tunneling Analysis*




## DEVELOPMENT HISTORY

**CRISP®** (CRItical State soil mechanics Program) is a nonlinear finite element program incorporating critical state soil mechanics theory. It was developed by research workers at Cambridge University Engineering Department from 1975 onwards and was first released publicly in 1982. The program was used mainly in academic circles and on mainframe computers until 1990, when a PC based version (CRISP90) operating under MS DOS was released. This release contained all of the features present in earlier versions, including the ability to model coupled loading and consolidation. In 1995, SAGE Engineering added a 2-D Microsoft Windows graphical user interface and technical enhancements to the latest version, to create **SAGE CRISP®** . In 2002 **SAGE CRISP® 3-D Bundle** product was released. The **SAGE CRISP® 3-D Bundle** includes the **FEMAP®** program, the **CRISP®** program and the **SAGE CRISP® 3-D Tools**.

**CRISP®** was one of the very first finite element programs to enable solution of modern soil mechanics problems. including fully coupled problems of pore water flow and effective stress modeled with the Critical State Theories of modern soil mechanics. The **(2-D) SAGE CRISP®** program was the first offering of a complete system (with interactive graphical model building, pre-processing and post-processing as well as problem solution) for finite element analysis of geotechnical problems including fully coupled problems of pore water flow and effective stress modeled with the Critical State Theories of modern soil mechanics. **The SAGE CRISP® 3-D**

**Bundle** includes a version of the **CRISP**® program capable of accelerated solution of large 3-D problems

The **FEMAP**® program is an interactive 3-D graphical program for geometric modeling and for pre- and post-processing of finite element work. It includes powerful capabilities for graphical display and presentation, not only for geometric modeling but also for finite element models and results

**SAGE CRISP® 3-D Tools** is a collection of programs, files and utilities which enable the combined use of the **CRISP**® and **FEMAP**® programs as a complete system for 3-D finite element modeling, analysis and presentation.

Major universities, engineering firms, production industries, and government agencies are making increasing use of the **SAGE CRISP**® programs. At present the programs are used in hundreds of installations around the world.

## THE FINITE ELEMENT PROGRAM

The analysis program is undergoing continual development with work being carried out by research teams around the world. In particular, **SAGE CRISP**® is frequently used as a test bed for new constitutive models, which can be bolted onto the existing finite element code.

## ANALYSIS TYPES

**SAGE CRISP**® operates in two dimensional plane strain, or axisymmetry. The finite element program is also capable of analyzing three dimensional problems, although in the present version this capability is only available without the use of the GUI. The effective stress Principal is an integral part of the finite element analysis engine. Thus, **SAGE CRISP**® can perform drained, undrained and fully coupled (Biot) consolidation analyses.

## SOIL MODELS

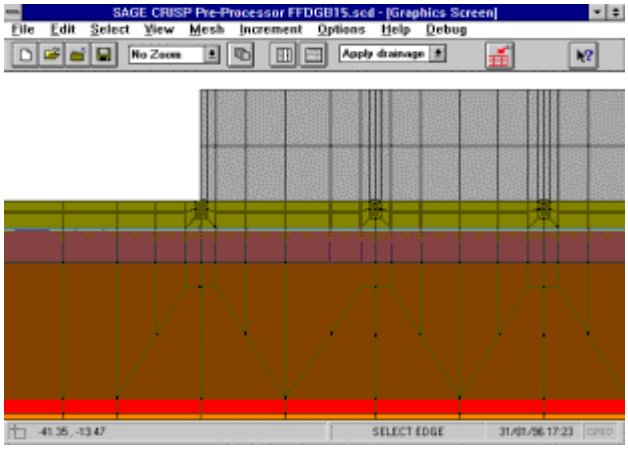
The adequacy of a finite element solution is largely dependant upon the constitutive models used. **SAGE CRISP**® incorporates six soil models and three structural models. These models have been developed over the course of the past 20 years, during which time they have achieved widespread recognition and respect. The soil models include linear elastic, elastic-perfectly plastic and critical state soil models, as listed below:

**Linear Elastic:**

- Homogeneous, anisotropic
- Non homogeneous, anisotropic

**Elastic-Perfectly Plastic:**

- Von-Mises
- Tresca
- Drucker-Prager
- Mohr Coulomb (associated flow rule)
- Advanced Mohr Coulomb model with non-associated flow and dual (friction and cohesion) hardening




**Critical State:**

- Cam clay
- Modified Cam clay
- Schofield model

**Additional:**

- Three-surface kinematic hardening model
- Duncan and Chang model

## FINITE ELEMENT TYPES

The accuracy of a finite element solution is directly related to the type of finite element used. **SAGE CRISP®** provides sufficient element types to give accurate solutions to most geotechnical problems. One, two and three dimensional elements are available along with an interface element for soil structure interaction analysis.

**1D Elements:**
(for plane strain analysis)

- 2 node bar (4 d.o.f.)
- 3 node bar (6 d.o.f.)
- 2 node beam (6 d.o.f.)
- 3 node beam (9 d.o.f.)

**2D Elements:**

(for plane strain and axisymmetry)

- 6 node linear strain triangle
- 8 node linear strain quadrilateral
- 15 node cubic strain triangle
- 22 node cubic strain triangle

**3D Elements:**

- 20 node linear strain brick

**Interface Elements:**

- 6 node interface element

## THE GRAPHICAL USER INTERFACES

The GUI's includes the following features:

- An easy-to-use graphical input window that allows you to create and alter models quickly and efficiently
- Point-and-click selection
- Automatic mesh generators
- Data entry via dialogue boxes, accessed from menus
- Display of construction sequences
- Graphical display of loads and fixities
- Complete control of all display options
- Zoom Pan and Rotate functions
- A material properties facility that can be set up with custom property values
- What-You-See-Is-What-You-Get printing of graphics
- Spreadsheet tools to enable the production of report output.

## ON-LINE HELP

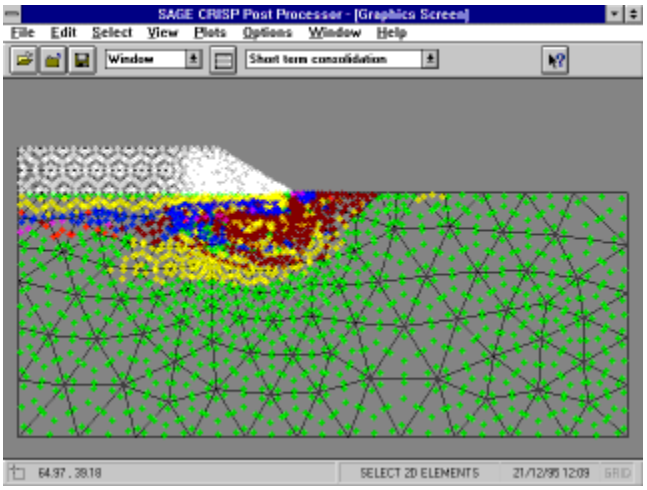
In-depth context sensitive help is available throughout the GUI's. Error and warning messages are also output by the analysis program.

## EXISTING PUBLICATIONS

An available Publications Directory contains reproductions of papers that have been published over the past 10 years whose content was derived through use of the CRISP analysis program. This is the most complete compilation of its kind and provides an comprehensive source of up-to-date reference describing the application of CRISP to a wide range of problems

*Cam Clay Stress State Codes*

## FEATURE SUMMARY




- 2-D Plane Strain or Axisymmetric Analysis
- 3-D Analysis
- Construction Sequences
- Graphical Display of Loads and Fixities
- Drained Analysis
- Customizable Display Options
- Undrained Analysis
- Automatic Calculation of In Situ Stresses
- Fully Coupled Consolidation Analysis
- Results Graphing Tools
- Triangular, Quadrilateral and Hexahedral Finite Elements
- Deformed Mesh Plots
- Structural Bar and Beam Elements
- Contour Plots
- Interface Elements
- Yield Status Plots
- Automatic Mesh Generation
- Principal Stress and Strain Plots

- Automatic Legend
- Graphical Model Creation
- Spreadsheet-Style Printed Output
- Point-and-Click Selection
- WYSIWYG Printing