MATERIAL RAMBERG-OSGOOD

Synopsis:
The MATERIAL RAMBERG-OSGOOD command is used to describe a time-independent Ramberg-Osgood material idealization [1].

Syntax:
MATerial RAMberg-osgood NUMber ##
   ( DScription "string")
   ( MODulus #.#) ( ALPha #.#) ( M_PARameter #.#)
   (SIGma_r #.#)

Explanatory Remarks:
The Ramberg-Osgood material idealization has the following form:

\[ \varepsilon = \varepsilon^e + \sigma \frac{\sigma_r}{E} \left( \frac{\sigma}{\sigma_r} \right)^m \]

where \( \varepsilon \) is the uniaxial strain in the material and \( \sigma \) is the associated stress. The elastic modulus is denoted by \( E \), and \( \alpha \) and \( m \) are dimensionless model parameters. The latter is an integer (input as a floating-point number) that specifies the strain-hardening characteristics of the material. Finally, \( \sigma_r \) is a reference stress. The first term \( \sigma/E \) in the above equation is seen to be the elastic strain; the second term is the plastic strain.

As readily evident from the syntax of the MATERIAL RAMBERG-OSGOOD command, the keywords MODULUS, ALPHA, M_PARAMETER and SIGMA_R correspond to the parameters \( E \), \( \alpha \), \( m \) and \( \sigma_r \), respectively. The default values for these parameters are \( E = 300000 \), \( \alpha = 1.0 \), \( m = 1.0 \), and \( \sigma_r = 1.0 \).

Remarks:
1. If \( m \) is very large, then the plastic strain remains small until \( \sigma \) approaches \( \sigma_r \), and increases rapidly when \( \sigma \) exceeds \( \sigma_r \). Consequently, \( \sigma_r \) may be regarded as an approximate yield stress.
2. In the limit as \( m \) approaches infinity, the plastic strain is zero when \( \sigma < \sigma_r \) is determinate when \( \sigma = \sigma_r \), and is infinite when \( \sigma > \sigma_r \) (and is thus impossible). This limiting case described a perfectly plastic solid with yield stress of \( \sigma_r \).

3. The Ramberg-Osgood idealization is particularly well-suited to representing the virgin curve of work-hardening solids, especially ones without a sharply defined yield stress [2].

Example:
To specify a hypothetical Ramberg-Osgood material idealization, enter the following command:

```
mat ramberg-osgood number 1 &
  desc "arbitrary material parameters" &
  modulus 1.20e+07 alpha 0.4286 m_param 11.0 sigma_r 43500.0
```

See also:
The NONLINEAR, DIMENSION and the ELEMENT BAR MECHANICAL commands.

References
