ELEMENT IRREDUCIBLE T10P0 command

Synopsis

The ELEMENT IRREDUCIBLE T10P0 command is used to describe all irreducible 10-node cubic triangular continuum elements that are to be used in mechanical analyses.

Syntax

The following syntax is used to describe a typical irreducible continuum element:

```
ELEment IRReducible TYPe T10P0 NODes #:##:
   (MATerial #) (INItial #) (THIckness #.##)
   (INTcode #)
   (CONstruction #) (EXCavation #)
   (DONT_PRINT_Results)
   (DONT_PRINT_STRAins) (DONT_PRINT_STREsses)
   (PRINT_PRIN_STRAins) (PRINT_PRIN_STREsses)
   (PRINT_VOLUMETRIC_STRAIN)
```

Explanatory Notes

- The T10P0 is an irreducible, cubic, isoparametric triangular continuum element. The element
  - Contains three (3) vertex nodes.
  - Contains three (6) mid-side nodes.
  - Contains one (1) interior node.
  - Has two (2) displacements degrees of freedom at each node.
  - Possesses a total of twenty (20) displacement degrees of freedom.

- The numbering order of NODES associated with T10P0 elements, which must be specified sequentially from 1 to 10, is shown in Figure 1.

  NOTE: Presently APES does not possess the ability to generate T10P0 elements. It is assumed that the analyst will thus use some stand-alone pre-processing software to accomplish this task. The resulting element and node data will then be translated to the format expected by APES.
• The **MATERIAL** keyword is used to specify the number of the material idealization associated with the element. The *default* values for the **MATERIAL** number is one (1).

• The **INITIAL** keyword is used to specify the initial state number associated with the element. The *default* value for the **INITIAL** is zero (0).

• The **THICKNESS** keyword is used to specify the material thickness assumed for the element. Over a given element, the thickness is assumed to be constant. The *default* **THICKNESS** value is equal to one (1.0). For **AXISYMMETRIC** and **PLANE STRAIN** idealizations (see discussion of the **ANALYSIS IDEALIZATION** command), the **THICKNESS** must be equal to 1.0. For such idealizations, specified values different from 1.0 are ignored and the proper value is used.

• The value specified in conjunction with the **INTCODE** keyword describes the order of numerical integration scheme to be used in developing the element equations for the element.

The “commonly” used numerical integration rule for **T10P0** elements corresponds to a 6-point numerical integration scheme (degree of precision equal to 4) for the primary dependent variables (i.e., nodal displacements) and a 4-point scheme (degree of precision equal to 3) for the secondary dependent variables (i.e., strains and stresses). This is the *default* condition and requires no input using the **INTCODE** keyword. If a quadrature order different from the default condition is desired, the following integer values are associated with this keyword:

**INTCODE = 43:** a 4-point numerical integration scheme (degree of precision equal to 3) is used to compute the primary dependent variables (i.e., nodal displacements) and a 3-point scheme (degree of precision equal to 2) is used to compute the secondary dependent variables (i.e., strains and stresses).

**INTCODE = 63:** a 6-point numerical integration scheme (degree of precision equal to 4) is used to compute the primary dependent variables (i.e., nodal displacements). A 3-point scheme (degree of precision equal to 2) is used is used to compute the secondary dependent variables (i.e., strains and stresses).

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Figure 1: Node Numbering Associated with a Typical Irreducible 10-Node (T10P0) Triangular Element
INTCODE = 64: a 6-point numerical integration scheme (degree of precision equal to 4) is used to compute the primary dependent variables (i.e., nodal displacements). A 4-point scheme (degree of precision equal to 3) is used to compute the secondary dependent variables (i.e., strains and stresses). This is equivalent to the aforementioned default setting.

- The incremental **CONSTRUCTION** and **EXCAVATION** numbers represent the time increment in which the material in this element(s) is added to or removed from the model. A **CONSTRUCTION** number equal to zero corresponds to a material in existence at the beginning of the analysis. Since this is the default condition, no input is required in such a case. The condition of no excavation is likewise the default.

- The purpose of the **PRINT** commands is to eliminate unnecessary output generated by APES. More precisely, if the time history of strains and/or stresses is desired only for a select few elements, this option greatly speeds program output and facilitates inspection of results by the user. Information associated with the elements specified in this section will be printed for every solution (time) step. If generation is performed using this **ELEMENT IRREDUCIBLE** command, then all the elements generated will be affected in a like manner by the above print control commands.

- Specification of the keyword **DONT_PRINT_Results** indicates that the analyst does not desire to see output of secondary dependent variables (i.e., strains and stresses) for this element.

- Specification of the **DONT_PRINT_STRAINS** keyword indicates that element strains are not to be printed. Under the default condition both strains are printed.

- Specification of the keyword **DONT_PRINT_STRESSES** indicates that stresses are not to be printed. Under the default condition stresses are printed.

- The **PRINT_PRIN_STRAINS** keyword indicates that principal strains are to be computed and printed for the element. Under the default condition these quantities are not computed and printed.

- The **PRINT_PRIN_STRESSES** keyword indicates that principal stresses are to be computed and printed for the element. Under the default condition these quantities are not computed and printed.

- The keyword **PRINT_VOLUMETRIC_STRAIN** causes the volumetric strain to be computed and printed for the element. In addition, the ratio of the absolute value of the volumetric strain to the absolute value of the minimum non-zero normal strain in the element is printed. That is,

\[
\frac{|\varepsilon_{\text{vol}}|}{\min(|\varepsilon_{11}|, |\varepsilon_{22}|, |\varepsilon_{33}|)} ; \quad \min(|\varepsilon_{11}|, |\varepsilon_{22}|, |\varepsilon_{33}|) \neq 0
\]

This ratio is instructive in the assessment of mixed and mixed/penalty elements used to simulate material response in the incompressible limit. As such, this keyword would likely not be used in conjunction with the **T10P0** element. Under the default condition the volumetric strain and the aforementioned ratio are not computed and printed.
Example of Command Usage
References
