AD FALCON API Manual

Material Models: Syntax & Conventions

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1 Material Models: Syntax & Conventions

This page documents the common input-file conventions used by all material-model directives. Use it as a reference before reading the model-specific pages.

1.1 Syntax

The conventions below apply to material directives such as `@UMAT:`, `@Perm:`, `@SWRC:`, `@EffectiveStress:`, `@PhaseChar:`, and `@AnisotropicPerm:`. They are designed to be robust to minor formatting differences (such as extra leading `@`, colon spacing, and directive name capitalization).

1.2 Where material models are defined

Material models are defined inside the `% Materials` section. Each material starts with a material ID line, followed by one or more property directives:

```
% Materials
MyMaterial
@UMAT: /path/to/LinearElasticUMAT.cpp /path/to/LinearElasticUMAT.hpp
Mechanical YoungsModulus=1e8 PoissonsRatio=0.3
@PhaseChar: Liquid rhow 1000 l_vicosity 1e-3 K_l 2.2e9
@Perm: VanGenuchten m 0.9 k_sat 1e-10
%%%
```

Notes:

- The material ID is the full line. Keep it simple (no spaces) and use the exact same ID wherever the material is referenced.
- Each property directive must appear on its own line.

1.3 Property directive format

Most material-model directives follow one of these equivalent forms:

```
@Type: <ModelName> <key1> <value1> <key2> <value2> ...
@Type  <ModelName> <key1> <value1> <key2> <value2> ...
@Type:<ModelName> <key1> <value1> ...
```

General rules:

- The directive token (the part after `@`) is case-insensitive, and one or more leading `@` characters are accepted (for example, `@Perm`, `@@perm`, and `@@PERM:` are equivalent for directive lookup).

- A space after `:` is optional (`@Perm:VanGenuchten ...` and `@Perm: VanGenuchten ...` both work).
- The model name and parameter keys are typically case-sensitive; use the spelling shown in the model documentation.

1.4 Required properties by analysis type

The required properties for a material depend on the selected analysis type:

- **All analyses**: a mechanical model via `@UMAT:` (category `Mechanical`).
- **Coupled analyses**: also require a liquid phase (`@PhaseChar: Liquid ...`) and a permeability model (`@Perm: ...`).
- **Fully coupled analyses**: also require a gas phase (`@PhaseChar: Gas ...`), an SWRC model (`@SWRC: ...`), and an effective stress model (`@EffectiveStress: ...`).

1.5 Mechanical models via `@UMAT:`

Mechanical behavior is configured using `@UMAT:` in the `Mechanical` category. FALCON can be used with:

- UMATs provided with your FALCON installation (for example, `LinearElasticUMAT`), and
- your own UMATs (source or pre-compiled libraries).

Example:

```
@UMAT: path/to/model.cpp path/to/model.hpp Mechanical E=1e8 Nu=0.3
```

1.6 Optional anisotropy (permeability)

If `@AnisotropicPerm:` is provided, its coefficients scale the permeability directionally. If it is omitted, isotropic behavior is assumed.

1.7 Recommended style

- Use exactly one leading `@` and include a colon: `@Perm: ...`
- Keep material IDs short and without spaces.
- Keep each property on a single line.