



AD FALCON API Manual

# van Genuchten SWRC Model

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## Contents

<b>1</b>	<b>van Genuchten SWRC Model</b>	<b>3</b>
1.1	Syntax . . . . .	3
1.1.1	Parameters . . . . .	3
1.2	References . . . . .	4



## 1 van Genuchten SWRC Model

### 1.1 Syntax

Specify this model in % Materials using @SWRC::

```
@SWRC: NonHysteretic alpha_1 <alpha_1> n <n> m <m> omega_prime <omega_prime>
[SW_max <SW_max>] [SW_min <SW_min>] [st <st>]
```

Notes:

- NonHysteretic is the model keyword for the van Genuchten SWRC in input files.
- SW\_max, SW\_min, and st are optional.

#### 1.1.1 Parameters

Input keyword	Symbol	Meaning
alpha_1	$\alpha_1$	Shape/air-entry parameter (used in Eq. (1)).
n	$n$	Shape parameter controlling slope.
m	$m$	Shape parameter controlling curvature.
omega_prime	$\Omega'$	Void-ratio influence in modified suction $p_c^* = p_c e^{\Omega'}$ .
SW_max	$S_{r-max}$	Maximum degree of saturation (optional).
SW_min	$S_{r-min}$	Minimum degree of saturation (optional).
st	$st$	Threshold parameter in the suction correction factor $C_s(p_c)$ (optional).

#### Modified van Genuchten Model

To account for the effects of volume changes on the soil water retention curve (SWRC), we define a modified suction,  $p_c^* = p_c e^{\Omega'}$ , where  $\Omega'$  is a material parameter representing the influence of the void ratio,  $p_c$  is the suction, and  $e$  is the void ratio.

By neglecting hydraulic hysteresis, the non-hysteretic van Genuchten model for the SWRC is expressed as

$$S_e = \left[ 1 + (\alpha_1 p_c^*)^n \right]^{-m} \quad (1)$$

where  $\alpha_1$ ,  $n$ , and  $m$  are model parameters that control the shape of the retention curve. In addition, the model considers the maximum and minimum degrees of saturation, denoted by  $S_{r-\max}$  and  $S_{r-\min}$ , respectively, so that the effective degree of saturation is given by

$$S_w = S_{r-\min} + (S_{r-\max} - S_{r-\min}) S_e \quad (2)$$

A correction factor,  $C_s(p_c)$ , is introduced to account for additional effects due to suction. This factor is defined as

$$C_s(p_c) = 1 - \frac{1 + \ln\left(\frac{\max(p_c, \text{TINY})}{st}\right)}{1 + \ln\left(\frac{10^6}{st}\right)} \quad (3)$$

where TINY is a small constant, 1E-12, to avoid singularities and  $st$  is a threshold parameter. Note that the threshold parameter  $st$  is not compulsory; if the user does not provide a value for  $st$ , the correction factor  $C_s(p_c)$  is assumed to be deactivated (i.e., set equal to 1).

The modified van Genuchten SWRC is then given by

$$S_w = C_s(p_c) \left[ S_{r-\min} + (S_{r-\max} - S_{r-\min}) \left( 1 + (\alpha_1 p_c^*)^n \right)^{-m} \right] \quad (4)$$

This formulation integrates the influence of volume changes through the modified suction and adjusts the retention curve via the correction factor  $C_s(p_c)$ .

Equations (1)-(2) are based on the classical van Genuchten retention law (van Genuchten, 1980). The additional void-ratio and suction-correction terms used here are part of FALCON's modified SWRC implementation for deformable unsaturated soils.

## 1.2 References

- van Genuchten, M. Th. (1980). *A closed-form equation for predicting the hydraulic conductivity of unsaturated soils*. Soil Science Society of America Journal, 44(5), 892-898. <https://doi.org/10.2136/sssaj1980.03615995004400050002x>