Implementation and evaluation of a slope stability equation performed with the DeltaLINK simulator

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Abstract

This poster presents the innovative Script Editor and Simulator features of DeltaLINK 3.0 software. This powerful new Script Editor function gives the user an accessible way to create and evaluate sophisticated mathematical functions and models that can be applied in real-time to the measurement data collected by the GP2 - providing useful outputs from the combination of different types of measurements and/or multiple sensors. Potential applications are numerous, including areas such as the calculation of evapotranspiration, irrigation control and disease prediction. In the simulator work shown below we demonstrate added functionality that can be installed into the GP2 Logger and Controller – using soil moisture and tension sensors data to estimate slope stability safety factor (FS) in response to rainfall events.

Applying the GP2 to calculate slope stability Safety Factor

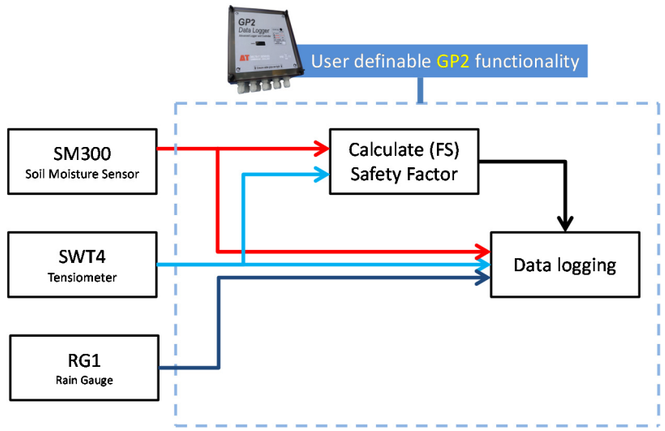


Fig. 1 – Block diagram showing the implementation of Safety Factor model implemented.

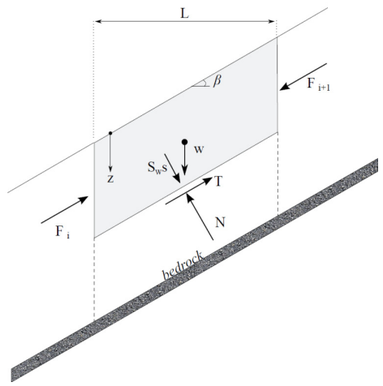
- **GP2 - Advanced Data Logger and Controller**

- **SM300 Soil Moisture and Temperature Sensor**

- **SWT4 Tensiometer**

- **RG1 Rain Gauge**

Safety Factor (FS) model



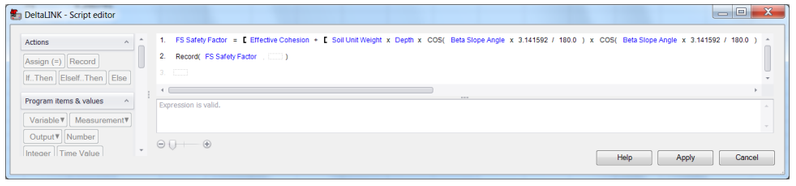
$$FS = \frac{c' + [\gamma \cdot z \cdot cos^2\beta + S_w s] \cdot \tan\varphi'}{\gamma \cdot z \cdot \cos\beta \cdot \sin\beta}$$

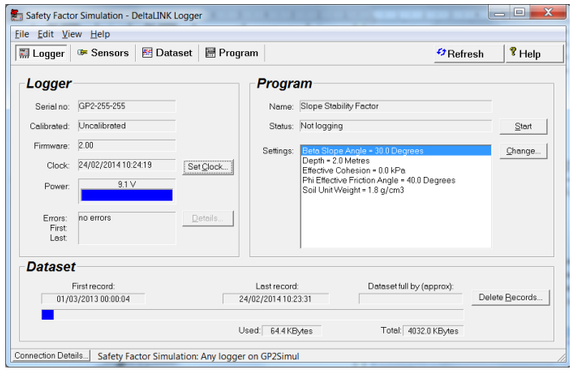
Where:

- β: slope angle
- z: soil depth
- γ: soil unit weight
- c': effective cohesion
- φ': effective friction angle
- s: water tension
- S_w: water content

The implementation of the Safety Factor model in DeltaLINK

DeltaLINK 3.0 Script Editor and Simulator features were used for this evaluation of the Safety Factor model. The mathematical model, shown above, was implemented using the Script Editor; a sample of the script is shown below.





Site specific variables have been included in the GP2 program as user adjustable parameters that can be easily set for each location using the GP2's DeltaLINK control panel and the Program Settings window, as shown here on the left.

DeltaLINK Simulator output

The data created during the simulation is recorded by the DeltaLINK software and a 10 day period of simulated rainfall, soil moisture and soil tension data with output from the Safety Factor model is shown in Figure 2 below.

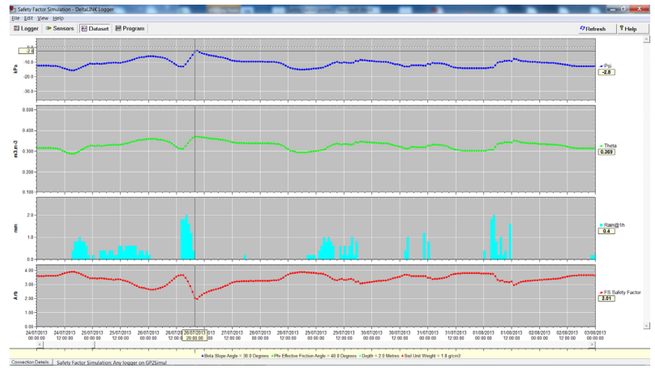
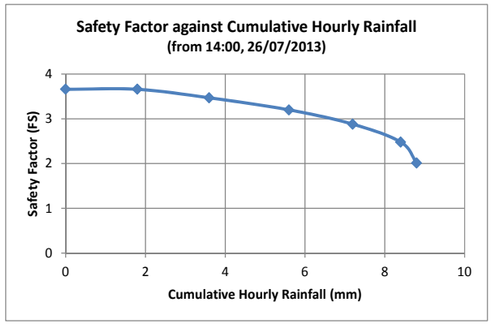


Fig. 2 – DeltaLINK Simulator output for a 10 day period showing rain gauge, soil moisture, and soil tension data and the output from the Safety Factor model

In Figure 2 the soil moisture and soil tension simulated data responds appropriately to rainfall events and the Safety Factor model is processing this data to provide values that are in-line with expectations. Further verification and data process can be performed by downloading the simulated data to an Excel spread sheet.



An example of Excel based data processing is shown here on the left where Safety Factor has been plotted against cumulative rainfall for the significant rainfall event of 26th July 2013 as shown in Figure 2. Post-processing of simulated data can help review experimental arrangements.

Conclusions

The simulator feature enables the user to quickly apply and review mathematical functions, models and experimental methods. This capability may also help users to plan and develop experimental programmes prior to time consuming experimental work. In this poster simulated rainfall, soil moisture and tension data has been used to evaluate the use of a slope stability model.

For more information regarding this and other GP2 Script Editor applications please contact: sales@delta-t.co.uk , regarding the Geotechnical & Environmental Research Group please contact: www-geo.eng.cam.ac.uk

DeltaLINK 3.0 including the Simulator is available free of charge at www.delta-t.co.uk