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Calibration of Sand Production Prediction Models at Early Field Life in the Absence of Sanding Data

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Abstract

The risk of sand production must be evaluated from very early stages of field development planning to select the optimum well completion, and if required, identify the appropriate sand control options. However, during appraisal or early development stages, sanding predictions often cannot be verified against field data because the lack of sanding observations. The analysis of predicting the onset and rate of sand production generally consists of using analytical or numerical rock mechanical models and ideally calibration with field sand production data. In this paper we show how in the absence of field sanding data, reliable sanding predictions can still be achieved by combining commonly used analytical and numerical prediction methods. This approach has been validated using a brown field data from South East Asia with several sand producing wells and multiple pressure depleted reservoirs.

The analytical method uses a poro-elastic model and core-calibrated log-derived rock strength profiles with an empirical effective rock strength factor (ESF). The ESF should be calibrated against documented field sanding observations from wells with credible formation and drawdown pressures. The numerical method uses a poro-elasto-plastic model defined from triaxial core tests. The rock failure criterion in the numerical method is based on a critical strain limit (CSL) corresponding to the failure of the inner wall of thick-walled cylinder core tests or field sanding data if existing (Figure 1).

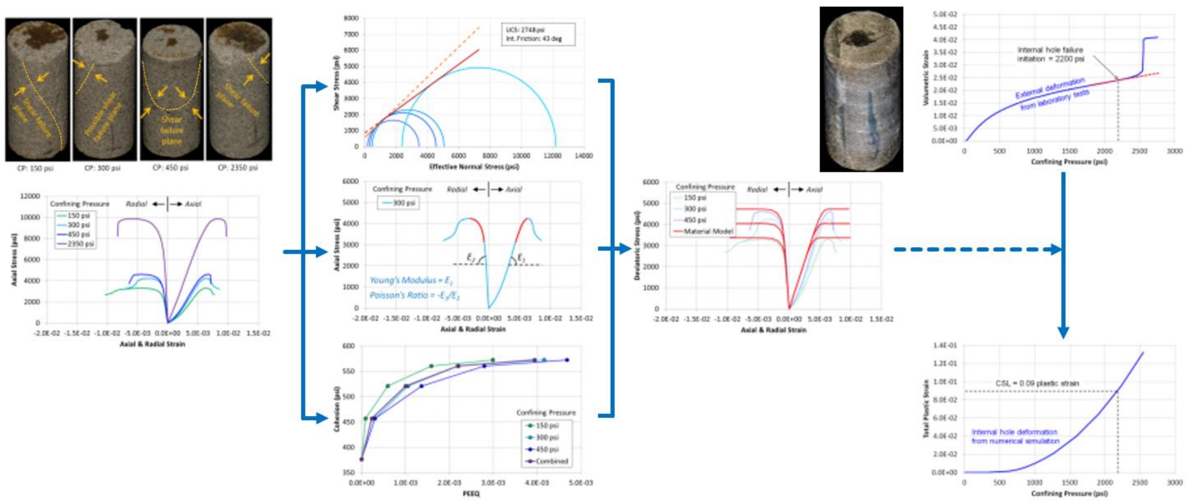

Figure 1. Material modelling steps and defining the critical strain limit (CSL) from the TWC test.

In the brown oil field example, both analytical and numerical methods accurately predict the onset of sanding in the sand-prone wells. The core-based CSL defined by the numerical method match very well with the field sanding data with a very small margin of error. In contrast, the default and non-calibrated ESF values commonly used in the analytical method required considerable tuning to match with the field sanding data. After the field validation (Figure 2), the predictions for planned infill wells by both analytical and numerical

methods were consistent and similar.

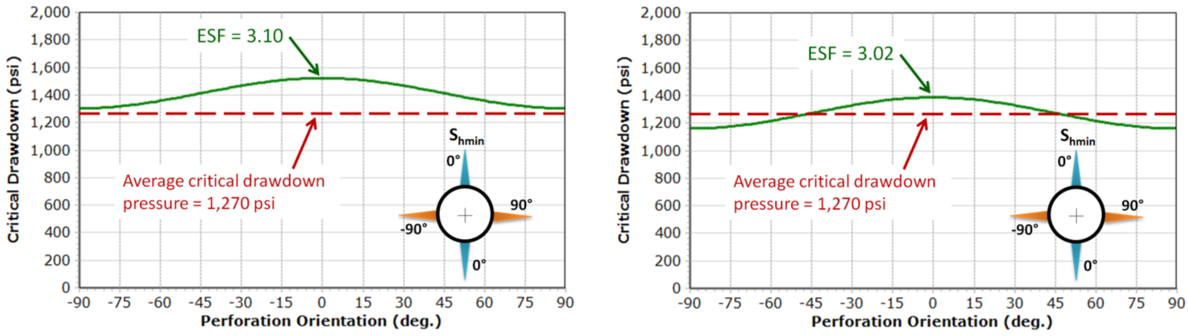

Figure 2. Matching analytical results against the average of numerical results.

The paper will show how this approach is used in two other fields at appraisal stage from the Asia Pacific region. Both cases are showing that very different ESF values are required to match with the numerical simulations. In the absence of field sanding observation, particularly in the early stages of development, the use of non-calibrated default ESF values in the analytical method could lead to erroneous sanding assessment and poor sand management decisions. Application of a combined analytical and numerical sanding evaluation enhances the reliability of sand production predictions. After a calibration is obtained, the analytical method can be used with confidence and has the added benefits of simplicity and quick realizations of various scenarios and output plotting capabilities and inputs for sand control and well completion decisions.