# PRESSURES EXERTED ON SILO WALLS DUE TO INFILL BULK MATERIAL DISCHARGE

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Silos are one of the most common containment structures used in industrial applications worldwide for the storage and handling of bulk granular materials such as grains, cement, coal, fertilizers, minerals, chemicals, etc. These structures are mainly constructed in steel or concrete and consist of a bunker and a hopper section at the bottom which can take different sizes and shapes. However, safe operation and design of silos have become difficult to a certain extent mainly due to the complex behaviour of infill bulk material during the discharge state. Hence, the design of silos is governed by dynamic discharge conditions for the most part. Past studies have shown that numerical methods such as the Finite Element Method can capture dynamic behaviour reasonably over codes of practice. However, further optimisation of such Finite Element simulation is necessary to improve the accuracy while reducing the computational cost.

This project studies the influence of the bulk material constitutive relationships in silo wall pressure prediction used in numerical and theoretical techniques. Although in static conditions, bulk materials can withstand loads in shear, in dynamic flow conditions they tend to behave erratically leading to failure. Two of the most widely used constitutive relationships were explored in this sense; the (i) Mohr-Coulomb relationship and the (ii) Drucker-Prager criterion. Bulk material discharge simulation is performed using the Finite Element Method to capture the peak wall pressure at the bunker-hopper transition of the silo.

Numerical results obtained from the Finite Element model were verified against a comprehensive experimental study. It is found that the numerical method provides better results compared to theoretical methods available. Eurocode predicts fairly accurate results although with some overestimation which can be expected due to the incorporation of safety factors in design codes. The Mohr-Coulomb stress-strain relationship can be recommended as the most appropriate constitutive model for representing wheat as bulk material as it predicts results with almost 100% accuracy. Contrary to that, the Drucker-Prager criterion tends to under-predict results. This needs to be further investigated.

The influence of the lateral pressure coefficient as well as the discharge velocity on discharge pressures have also been explored in this study briefly. It is observed that the numerical method better predicts the lateral pressure coefficient. Moreover, when the discharge rate of the bulk material is increased the peak pressure tends to reduce. However, these aspects will have to be studied in detail before coming to any conclusions.

As far as this study is considered, a numerical model with the Mohr-Coulomb relationship as the material constitutive relationship can be deemed valid in predicting discharge pressures in silos with an acceptable level of accuracy.

**Keywords: design of silos; wall pressure; bulk material discharge; finite element simulation**

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