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Optimization of the breaking force and tensile strength relationship of doubly convex tablets under diametrical compression

Modarres Razavi, Sonia, sonia.m.razavi@gmail.com, Rutgers University

ABSTRACT

The mechanical strength of pharmaceutical tablets is an important quality factor that is tested during tablet production to ensure that tablets endure postcompaction loading. Diametrical compression test is the most common method to measure the breaking force of the tablet. Converting the breaking load into a value of tensile strength is analytically done for flat cylindrical tablets by Hertz solution. However, stress analysis is not simple for more complicated geometries of tablets. There have been various empirical solutions presented to calculate the tensile strength of doubly convex tablets based on experimental data. This study aims to find the optimum relationship between the breaking force of a doubly convex tablet to the material tensile strength subject to diametrical compression. Here we assume that tensile strength is a material property which solely depends on the relative density of the tablet. By testing a small number of flat faced tablets, we can easily find the relationship between the tensile strength and relative density of the tablets. Utilizing this relationship enables us to construct our optimization problem by relating the tensile strength of a flat faced tablet to a doubly convex one having the same relative density. However, we should restrict attention to the failure pattern which corresponds to crack formation and propagation under pure tensile stress as the case seen in a flat tablet. The proposed model is reducible to the Hertz solution and thus can be applied for flat-faced tablets as well. It is observed that a small number of accurate measurements of flat tablets are sufficient for obtaining a representative calibration when the equation is forced to reduce to the Hertz solution. We made a rigorous comparison between all the proposed models by applying three equivalent optimization problems and calculating the corresponding two norms. Because we cannot eliminate experimental errors, we tried to minimize the norm to provide more stability. At the end, we have determined the most stable optimization problem and conclude that our model shows a better fit compared with the earlier models.