Analyses of distribution of forces and cutting action on a single wear cutter

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The blunt bit is one of the important factors that could lose drilling efficiency during deep or ultra-deep drilling. This paper presents a mechanical model of the wear cutter-rock interaction model by simplifying the wear areas to arc-shaped. Analyses on the cutting force distribution and the cutting action on rock of a single wear cutter by theoretical and simulation methods. The results show that (a) the stress areas and the stress distribution extend in a sector shape on the cutter front active area, and the maximum stress concentrates on the cutter edge near the rake face, wear causes a decrease in the oscillation frequency of stress fluctuation. (b) The variation features of the main cutting force which is considered as the reaction of the rock acting on the rake face are investigated. At the start, the cutting force from the maximum is reduced sharply as the wear cutter radius increases and reaches the lowest value when the wear radius ranges between 0.7 and 0.9 mm, and then increases smoothly. (c) The friction increases with the wear arc flat formation and effects the bottom of the cutter, resulting in repeated crush of rock fragments. Thus chippings generated as a result of fracture have a small size. Finally, we propose a pre-reverse arc cutter structure, which can reduce the cutter wear and provide a theoretical basis for optimization design of the PDC bit.