

Failure mechanism of roof directional cutting technology and optimization of design method

Shilin Hou^{1,2}, Jun Yang^{1,2}, Yajun Wang^{1,3*}, Jun Zhang^{1,2*}, Manchao He^{1,2}, Gang Yang^{1,2},

¹ State Key Laboratory for Tunnel Engineering, China University of Mining & Technology Beijing, Beijing 100083, China

² School of Mechanics and Civil Engineering, China University of Mining & Technology Beijing, Beijing 100083, China

³ School of Civil and Resource Engineering, University of Science and Technology Beijing, Beijing 100083, China

摘要: Roof directional cutting (RDC) technology is one of the key techniques in non-pillar coal mining with self-formed entries (NCMSE) mining method. Due to the inability to accurately measure the expansion coefficient of the goaf rock mass, the implementation of this technology often has unreasonable designs, leading to suboptimal results and increased costs. This paper establishes a structural analysis model of the goaf working face roof, revealing the failure mechanism of RDC technology, and through numerical simulation experiments, it clarifies the positive role of RDC technology in improving the stress of the roadway surrounding rock and reducing the subsidence of the roof. On this basis, the paper further analyzes the roadway pressure and roof settlement under different RDC design heights, and ultimately proposes an optimized design method for the RDC height. The results show that the implementation of RDC technology can significantly optimize the stress environment of the working face roadway surrounding rock. At the same time, during the application of RDC technology, there may be three situations: insufficient, reasonable, and excessive RDC height. Insufficient height will significantly reduce the effectiveness of the technology, while excessive height has little impact on the implementation effect but will significantly increase construction costs and difficulty. Engineering verification shows that the RDC technology optimization design method proposed in this paper reduces the peak stress of the protective coal pillar in the applied roadway by 27.2% and the central subsidence of the roof by 41.8%, demonstrating good application results. This method provides technical support for the further promotion of NCMSE mining method.

关键词: Roof directional cutting technology; Roof structure; Failure mechanism; Numerical simulation; Optimized design method; Engineering verification