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围压与温度共同作用下盐岩的SHPB实验及数值分析

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SPLIT HOPKINSON PRESSURE BAR TEST AND NUMERICAL ANALYSIS OF SALT ROCK UNDER CONFINING PRESSURE AND TEMPERATURE

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摘要 在自主研制的可进行围压和温度共同加载的分离式Hopkinson压杆(SHPB)实验装置TSCPT-SHPB基础上，对盐岩在5～25 MPa围压作用下的轴向动力性能以及盐岩在40 ℃～80 ℃，0.0～0.5 MPa围压下进行实验研究，分析围压和应变率对盐岩在围压作用下轴向抗压强度动力增长系数(DIF)的影响，以及温度和围压对盐岩动态力学性能的影响。结果表明：在动态作用下，围压对盐岩延性的提高有显著影响；盐岩属率敏感性和温度敏感性材料，其峰值强度随应变率的提高而提高，在低围压下的提高幅度比高围压下显著，并得到实验范围内盐岩材料动力增长系数(DIF)与围压和应变率关系的表达式；在高应变率(400 s－1)条件下，盐岩的动态峰值强度随温度的升高而降低，并依据实验数据，拟合得到峰值强度在各实验温度下随围压变化的计算公式。为考虑应变软化效应，对ABAQUS有限元软件中的Drucker-Prager模型进行改进，并基于单向动态围压下的实验数据拟合的计算参数，对盐岩TSCP-SHPB实验进行数值模拟，模拟结果与实验结果吻合较好。

关键词： 岩石力学 盐岩 分离式Hopkinson压杆(SHPB) 围压 应变率 动力增大系数(DIF) 温度

Abstract： A special split Hopkinson pressure bar(SHPB) under confining pressure and temperature，triaxial static confining pressure and temperature split Hopkinson pressure bar(TSCPT-SHPB)，is designed. The uniaxial dynamic mechanical performances of salt rock with the confining pressures ranging from 5 to 25 MPa were studied experimentally and numerically. The salt rock under the condition of temperature ranging from 40 ℃ to 80 ℃ and the confining pressure from 0.0 to 0.5 MPa was also tested with the TSCPT-SHPB. The influences of the confining pressure and strain rate on the dynamic increasing factor(DIF) of axial compressive strength of salt rock and the effects of the temperature and confining pressure on the dynamic mechanical properties of salt rock were analyzed. It is demonstrated that：(1) The effect of confining pressure on the ductility of salt rock is tremendous under dynamic loading. (2) The salt rock is a rate-dependent and temperature sensitive material；and its maximum dynamic compressive strength increases as the strain rate increases；while the peak dynamic compressive strength of salt rock decreases as the temperature increases under the high strain rate of 400 s－1. It is noted that the increase of the maximum dynamic compressive strength under low confining pressures is more obvious than that under high confining pressures. (3) The approximate expression for the effect of confining pressure and strain rate on DIF of salt rock was presented；and the relationship between peak confining strength and temperature under the high strain rate of 400 s－1 was also obtained from the test data. The experimental results by the TSCP-SHPB were validated by numerical simulation，in which the modified Drucker-Prager model and its experiment-based parameters were used.

Keywords： rock mechanics salt rock split Hopkinson pressure bar(SHPB) confining pressure strain rate dynamic increasing factor(DIF) temperature

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