ABSTRACT

The investigations carried out aimed at the development of a better understanding of the heat and moisture transfer from surrounding rock into mine roadways. Laboratory experiments were conducted on circular and square concrete ducts for three different roughness conditions with external heating arrangement to simulate heat flow into underground mine roadways. Gardon type heat flux sensors were used for the direct measurement of convective heat flux from rock surface. These sensors are convenient for the direct and rapid estimation of convective heat flux, and produced errors in the range of 12 to 18 percent. The experimental results were compared with various heat transfer analogies and relationships in use, to investigate their applicability for naturally rough surface condition like those in underground roadways. Two analogies for prediction of convective heat transfer and moisture transfer in mine roadways were proposed based on the experiments. A relationship between roadway surface roughness factor, and friction coefficient was developed.

Theoretical investigations were carried out to establish the effects of the stratification of rock, insulation of mine roadways, and roadway shape on heat flow. The study aimed at producing better solutions to radial heat conduction problems and better climate prediction models. With the exception of the work related to climate prediction, the theoretical investigations were performed with the help of a finite element software, ANSYS. The investigations lead to the following conclusions. Gibson

algorithm provides a rapid and accurate simulation to the radial heat conduction problem and the results compared favourably with those from the fine mesh analysis in the solution region. The roadway shape has negligible effect on heat flow into the mine air. The use of equivalent thermal conductivity model in place of the actual stratification, for heat flow estimation leads to an over-prediction by 10 to 30 percent. Thermal properties of rock lying within 4 to 5 times the roadway size, measured from the centre of the opening, only contribute to heat flow. Shotcrete is twice as good as concrete for insulation effects. Synthetic insulation materials like PUR are clearly superior and beneficial up to a thickness of 50mm, beyond which insulation advantages are marginal. The proposed climate prediction models resolved satisfactorily some of the important discrepancies and shortcomings in the existing models.

Key Words : UNDERGROUND ROADWAY, RADIAL HEAT CONDUCTION, CONVECTIVE HEAT AND MOISTURE TRANSFER, HEAT FLUX SENSOR, ROUGHNESS FACTOR, FEM ANALYSIS, STRATIFICATION, INSULATION, CLIMATE SIMULATION MODELS.