In India, about 98% of underground output of coal is obtained by bord and pillar method and remaining by longwall method. In India, around 70% of total coal reserve now available is amenable for extraction by underground coal mining methods. Therefore, the coal mining industry in the country is gearing up to strengthen underground coal production. Bord and Pillar Mining is a unique challenging branch of engineering. The primary objective is extraction of coal with rock failure whereas if rock fails – it is a problem; and if not – it is a major problem. Extensive research after coal brook colliery disaster of South Africa in January 1960 made underground coal mines a lot safer. Even then, a much debate persists regarding efficacy and quantification of safety with the bord and pillar mining. The most troublesome part is depillaring operations where small remnant pillars are left for short-term stability. Smaller remnant pillars fail early and rapidly transfer the load in working area making depillaring unsafe. Bigger remnant pillars delays failure of roof rock in goaf which may cause large scale cascading failure and invariably results into permanent loss of finite coal reserves. There is no acceptable technology which can measure the deformation behaviour of the remnant pillars and / or roof rock of goaf area. This dissertation is aimed to develop a suitable technology to improve the safety and productivity of depillaring operations of underground coal mining, by designing and developing an instrument for measuring the deformation of goaf area and providing early warning about roof failure.

Several researchers and the workplace environment of depillaring operations indicate for deformation measurement as sole indicator to characterise the behaviour of remnant pillars or the goaf area. A prop for abutment deformation measurement (Acronym as PADM) is designed and developed through the research work undertaken for this dissertation. A holistic approach is undertaken for development of PADM which involves a critical analysis of the reported field evidences, physical conceptualisation and development of PADM, field behaviour analysis of PADM and substantiation with numerical modelling of depillaring operations of the case study.

PADM is a very low stiffness telescopic prop which measures convergence between roof and floor in the goaf area. The convergence observations are conveyed in tell-tale manner with suitable colour coded warning indicators with three distinct risk levels. Electronic recorder version of PADM has also been developed which records, communicates, stores and analyse convergence data using self-healing wireless communication protocol of mesh networking.

The development of PADM has also been verified with a field application of depillaring panels of an underground coal. PADM observations are compared with indictor props and auto-warning tell-tale (AWTT). Reliability of PADM observations are found superior than prevalent observational techniques. PADM consistently observed that a convergence of at least 100 mm is required before a fall to take place in goaf area at the selected coal mine.

Numerical analysis is also carried out for predicting the goaf area deformation during depillaring operations of the field case study. Major input parameters for the numerical analysis are obtained using field and laboratory testing. The predicted deformation values are compared with the measured values of PADMs. The numerical analysis also substantiated the fact that a deformation of at least 100 mm reached before the failure of remnant pillars in goaf area, as observed by field measurements.