Abstract

We focus on the research and development of Fiber Bragg Grating (FBG) sensors for geophysical monitoring, specifically in the context of assessing civil structures at an early age and conducting vibrational analysis. FBG sensors are a promising sensor in the geophysics due to their several advantages like multiplexing, high sensitivity, immunity to electromagnetic interference and small size. The primary parameters monitored are temperature and shrinkage to understand the behaviour and performance of tunnels during early construction phases. The research aims to detect excessive shrinkage and thermal gradients that may lead to cracking, allowing for optimization of cement material and water/cement ratio selection. Two component grouts used for the backfilling in the tunnelling is used as the material for investigating the early age parameters. From the analysis it is observed that the maximum shrinkage occurs in the initial hours of casting then it is decreased gradually and remains a constant value at about 16 days of casting. From the temperature measurement the setting stage of the two-component grout is about 90 minutes. We can conclude from the analysis that all these samples can be used for backfilling in tunnel because the influence of temperature is very less, and the shrinkage is not more than 500 micro strain is suitable for the back filling in the tunnel. Additionally, the thesis explores the design, optimization, fabrication, and testing of FBG cantilever beam-based accelerometers for measuring vibrations from external seismic sources. Finite Element Method (FEM) simulations, calibration, and packaging of a simple cantilever beam-based accelerometer based on polylactic acid (PLA) are presented. The optimized system exhibits a resonance frequency of 75 Hz within a measuring range of 5-55 Hz and high sensitivity of ±433.7 pm/g. Field tests are conducted to compare the packaged FBG accelerometers with standard electro-mechanical geophones. Seismic sledgehammer shots are acquired along the tested line, and the experimental results from both systems are analysed and compared. The designed FBG accelerometers demonstrate their suitability for recording seismic traces and picking up first arrival times. The optimized system and potential further implementation hold promise for seismic acquisitions.