Non-destructive measurement of rubber bearing strain distribution

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Seismic isolation rubber bearings are widely used in the earthquake-proof buildings to protect people's lives and assets. The strain distribution in the rubber layer can be used to characterize the quality of rubber bearings. However, there are no appropriate methods to evaluate it nondestructively. Therefore, we present a novel method to measure the compressive stress distribution in the bottom rubber layer by embedding MEMS pressure sensors into rubber bearings. In our work, finite element simulations are conducted to study the compressive stress distribution in the bottom rubber layer in different conditions. It has a linear relation with the vertical load and becomes unsymmetrical when horizontal displacement exists. In order to measure the compressive stress in field test, a multi-buffer packaging method of MEMS pressure sensor is proposed to protect the sensors during the high temperature and high pressure rubber vulcanization process. The embedded process of pressure sensors is compatible with the original rubber bearing fabrication process and no destruction is introduced to the bearing. After that, pressure sensors are bonded with the bottom rubber layer. Thus the compressive stress in the bottom rubber layer in different positions can be measured real-timely. Four pressure sensors are embedded in the fixing plate of rubber bearing to discuss the effect of horizontal displacement and vertical load on stress distribution in the bottom rubber layer. The experimental results are consistent with the simulation ones and show that pressure sensors have a nonlinearity error of 1%FS with the measurement range of 3-21MPa. And there is a good corresponding relationship between horizontal displacement and the outputs of pressure sensors. It also shows a potential that the horizontal displacement can be calculated by the stress distribution in the bottom rubber layer. From the results of the simulation and experiments, this method is found to be effective for measuring strain distribution of rubber bearing and thus can be used for non-destructive testing of rubber bearings and structural health monitoring in the future.