APPLICATION OF PIEZOELECTRIC PATCH IN CRACK DETECTION AND REPAIR IN BEAM TYPE ELEMENTS UNDER STATIC AND DYNAMIC LOADS.

Thesis submitted by

GOUTAM ROY

Doctor of Philosophy
(Engineering)

DEPARTMENT OF MECHANICAL ENGINEERING

FACULTY COUNCIL OF ENGINEERING AND TECHNOLOGY

JADAVPUR UNIVERSITY

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Catastrophic failure of a structure or a machine element endangers human lives. The main cause behind this sort of failure is the propagation of a crack which leads to failure. At the primary stage of a crack, it may be dormant and can be repaired. So, the detection and repair of cracks is a crucial part of research in the field of mechanics. In this regard, several procedures are already developed. But still, in intricate structures consisting of beam-type elements, it is burdensome to take apart all the elements to facilitate crack detection and repair. The same problem comes in the case of machine elements also. Correspondingly another drawback of the already-developed detection techniques is they are not effective to detect tiny cracks. If the cracks are detected at a very early stage then they can be repaired and hence it is very significant to locate the crack when it has not considerably propagated. For this purpose, smart materials conceivably have the utmost potential. Among the different smart materials, piezoelectric ceramics are the most effective in terms of their performance and cost. Only limited works are so far carried out where piezoelectric patches are employed to act as either sensor or actuator to detect as well as to fix the crack in a beam. But those developed techniques are cumbersome, and not easy to employ. The present effort proposes easy and effective ways to employ piezoelectric patches to detect as well as repair a crack within beam-type elements. It is noted that an open crack in the beam discontinues the slope curve at the location of the crack. It leads a way for the detection of cracks. It is found that a piezoelectric patch can produce a voltage, proportional to this kind of the discontinuity. The first part of the present work shows how a crack potentially is identified in a beam under static load by using the piezoelectric sensor. A finite element model and Semi-analytical of the cracked beam with the attached piezoelectric patch are prepared to build up the procedure and the same is validated by the experimental result already published in a refereed

journal. Subsequently, it is revealed that by applying an external voltage field on a piezoelectric actuator a local moment can be generated near the crack which can nullify the discontinuity which had formed by the crack. It is proposed that this way a crack may be repaired in a beam. In the next part of the research, the same concept is applied to beams under vibration. To detect a crack in a beam under dynamic loading, finite element analysis, and analytical analysis is performed. In addition, an experimental setup is developed consisting of a digital oscilloscope, piezoelectric patch, cracked beam, beam holder, and exciter to validate the theoretically obtained results. At the last, the new crack identification technique has been used to model an instrument to measure the slope at a point on a deformed beam.