Crack Analysis of Composite Beam Using Vibration Analysis Method: A Review

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Abstract— Composites are one of the popular materials because of their variable applications going from the aviation to the farming items. They very often experience vibration during functioning. Various examinations showed that presence of Crack in composite constructions is one of the significant reasons for disappointments in composite laminate designs. Recognizing deformities in constructions and its members is a significant perspective in deciding about their maintenance and complete substitution. Inability to identify the shortcomings has different outcomes, and at times may prompt a disastrous failure. The present research work revealed scientific and experimental examinations on the impacts of a crack on the cantilever bar with rectangular section. The goal of this review is to measure and to decide the degree of the damage magnitude and location of cracks. In analytical examination, finite element method (FEA) programming was utilized in designing the model. The outcomes showed that, by checking the difference in the natural recurrence (frequency) it is a simple and reasonable method to demonstrate the damage intensity and size. But for small crack depth, the natural frequencies are not a decent damage locator. Mode shapes showed great affectability to recognize the damage extent for every crack parameters. The aim of this paper is to review the literatures on the impact of vibration on composite structures exposed to various limit conditions.

Keywords: Cracks, Dynamic Properties, Finite Element, Fiber Direction, Crack Location

I. INTRODUCTION

Beams are generally utilized as primary component in civil engineering, mechanical, maritime, and aeronautical designing. Failure is one of the significant viewpoints in primary investigation and designing. Damage investigation is done to guarantee the security as well economical development of the various industries. During analysis, all designs are exposed to degenerative impacts that may cause Commencement of the structural defects like cracks that advances with time and can lead to failure of the construction. To counteract such surprising or unexpected failure, prior crack identification is important. Contemplating this philosophy crack discovery is perhaps one among important study for researchers. Various researchers have proposed different methods for early recognition of crack area, size, depth and their pattern in a structure. Numerous non destructive methods for crack location have been being used around the world. It has been observed that vibration based technique is quick and cheap for crack detection

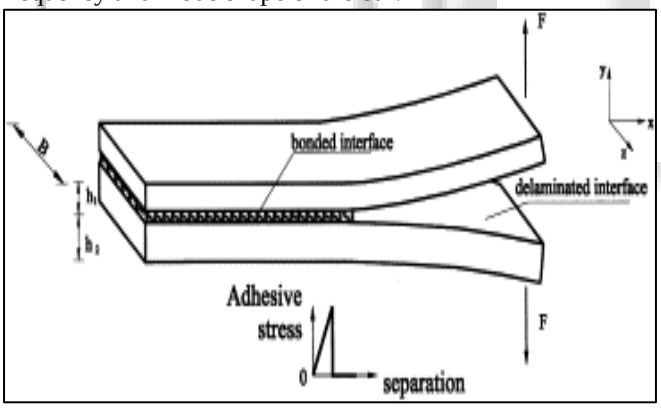
In this paper different economical, mathematical and experimental methods developed by different scientists for vibration examination of cracked bar have been presented. In this paper the impact of different boundary condition like crack size, crack area of bar on modular parameters exposed to vibration of a damaged bar have also been assessed.

1) Kim Kwangtung (2018) generated a crack Timoshenko bar model to analyze the vibration conduct dependent upon the ultra spherical polynomials. Timoshenko bar theory is applied to demonstrate the free vibration examination of the cracked bar and the numerical outcomes are determined by utilizing ultra spherical orthogonal polynomials. The end condition of the two ends of the cracked bar are prototyped in terms of elastic spring and the bar is split into two sections by the crack section, and constant conditions at the associating face are prototyped utilizing the reverse of the flexibility coefficients of crack mechanics hypothesis.
2) Gaith (2011) used a continuous cracked bar vibration theory for the transverse vibration of cracked Euler–Bernoulli bar with single-edge open cracks. In his analysis, the crack detection for simple supported graphite/epoxy fiber-built up composite bars was taken into account for study. The impacts of crack depth and position, fiber direction, and fiber volume percentage on the flexibility and therefore on natural recurrence (frequency) and mode shapes for crack fiber-built up composite bars are inspected.
3) Lu and Law (2009) explored such effect from numerous cracks in a finite element in the dynamic study and local damage recognition. The finite bar component was modeled using the composite element method with a single-member single-element arrangement with cracks where the interaction effect between crack in an equivalent element that was already included. The accuracy and convergence speed of the proposed model in computation were compared with existing models and test outcomes. The boundary of the crack model was found requiring change with the usage of the proposed model.
4) Wang, Inmana and Farrar (2004) analyzed the coupled bending and torsional vibration of a fiber-developed composite cantilever with an edge surface crack. The model relied upon linear crack mechanics, Castigliano's theory and conventional lamination theory. The crack was shown with a local flexibility matrix in a way that the cantilever bar could be supplanted with two intact bars with the crack as extra possible condition. The coupling of flexure and bend can result from either the material properties or the surface crack.
5) Zak, Krawczuk and Ostachowicz (2000) established the work models of a finite layered beam component and layered plate component. They performed a broad experimental examination to set up changes in the initial three bending natural frequencies due to splitting of layers of fiber. The further results of the mathematical computations were reliable.

6) Dimarogonas (1996) concluded a comprehensive audit of the vibration of cracked design structure. He covered a numerous territories that included cracked bars, coupled frameworks, flexible rotors, shafts, turbine rotors and blades, shells and pipes, and bars and plates with significant references.
7) Manivasagam and Chandrasekaran (1992) introduced results of experimental examinations on the decrease of the principal frequency of laminated composite materials with harm in the form of cracks.
8) Nikpur and Dimarogonas (1988) introduced the local compliance matrix (structure analysis) for unidirectional composite materials. They represented that the interlocking deflection modes are improved as a function of the level of anisotropy in composites.

II. DISCUSSIONS:

Fundamental frequency will reduce when depth of crack increase. Considering fixed crack depth, if the location of the crack gets closer to the center of the bar the value of fundamental frequency will decrease. The value of primary and secondary frequencies will decrease as the length of the fiber crack increases; however decrement in primary frequency is not significant. It was also concluded that natural frequency and mode shapes are highly dependent on the assumed constraints. It was concluded that double delimination will further reduce the value of natural frequency and mode shape of the bar.



When size of delamination is small, minor changes in natural frequency are resulted. It was observed that effect of multiple delaminations is more significant than that for single delamination. Declining frequency trend was concluded for constrained mode shape model. When a delamination occurs at the mid plane, minimum value of non-dimensional fundamental frequencies are resulted.

III. CONCLUDING REMARKS:

Vibration behavior in composite beam is point of interest to the researchers. Composite beam is widely used in almost every industrial application from simple mechanisms to various aviation and energy products. Presence of crack in the composite structure reduces the properties like stiffness and strength of the composite material and therefore decreases the life of the structure. It has been concluded that the changes in natural frequencies and mode shapes are two important parameters that determine crack size and location of the crack respectively. While reviewing the literature, it is proven that crack reduces the frequencies of the structures. The current research work is to review the vibration properties of composite structures with crack as crack is present in every component. The present research focuses the work already done in the field of vibration of composite structures with crack. Researchers are currently focusing on utilizing the concept of Artificial Neural Network (ANN), fuzzy Logic and genetic Algorithm as an effective tool for vibration analysis of damaged structures.

REFERENCES

[1] Gaith (2011). "Nondestructive health monitoring of cracked simply supported fiber reinforced composite structures. *Journal of Intelligent Material System and Structures*, 22(18).
[2] Lu and Law (2009). "Dynamic condition assessment of a cracked beam with the composite element model". *Mechanical Systems and Signal Processing*, 23, 415–431.
[3] Gaith (2011). "Nondestructive health monitoring of cracked simply supported fiber reinforced composite structures. *Journal of Intelligent Material System and Structures*, 22(18).
[4] Dimarogonas (1996). "Vibration of Cracked Structures: A State of the Art Review". *Engineering Fracture Mechanics*, 55(5), 831-857.
[5] Przemieniecki J. S. *Theory of Matrix Structural Analysis*. London: McGraw Hill first edition (1967). 191-201.
[6] Ramanamurthy (2008). "Damage detection in composite beam using numerical modal analysis". *International Journal on Design and Manufacturing Technologies*, Vol.2, No.1.
[7] Tita and Carvalho (2003). "Theoretical and experimental dynamic analysis of fiber reinforced composite beams". *Journal of the Brazilian society of Mechanical Sciences and Engineering*. Vol. xxv, No.3.
[8] Vinson and Sierakowski (1991). *Behavior of Structures Composed of Composite Materials*,1st edn. Dordrecht: Martinus Nijhoff.

