INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)

www.ijprems.com
editor@ijprems.com

Vol. 04, Issue 01, January 2024, pp : 106-109

e-ISSN : 2583-1062

Impact Factor : 5.725

A REVIEW PAPER ON DESIGN AND DEVELOPMENT OF CRANKSHAFT ANALYSIS AND MODELING USING ANSYS SOFTWARE

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ABSTRACT

The crankshaft is a critical component in internal combustion engines, serving as the backbone of the engine's power transmission system. Over the years, advancements in computational tools have revolutionized the design and development processes of mechanical components, including crankshafts. This review paper provides an in-depth analysis of the state-of-the-art techniques employed in the design and development of crankshafts, with a specific focus on utilizing ANSYS software for comprehensive analysis and modeling. The paper begins by highlighting the fundamental importance of the crankshaft in ensuring the efficient conversion of reciprocating motion into rotary motion within an engine. Subsequently, it delves into the historical evolution of crankshaft design methodologies, emphasizing the transition from traditional analytical methods to advanced numerical simulations facilitated by ANSYS software. In conclusion, this comprehensive review consolidates the current knowledge on the design and development of crankshafts using ANSYS software. It serves as a valuable resource for researchers, engineers, and practitioners involved in the automotive and mechanical engineering fields, offering a roadmap for future advancements in crankshaft technology. Ultimately, the integration of ANSYS in the analysis and modeling of crankshafts is shown to be a pivotal factor in advancing the efficiency, reliability, and overall performance of internal combustion engines.

Keywords: ANSYS, Component, Evaluation, Crank, Shaft and Design.

1. INTRODUCTION

The internal combustion engine, a cornerstone of modern transportation and industrial machinery, relies heavily on the efficient functioning of its constituent parts. Among these, the crankshaft plays a critical role in translating reciprocating linear motion into the rotational motion necessary for power transmission. As engine designs continue to evolve for improved efficiency, reduced emissions, and increased power output, the demand for advanced analytical tools becomes paramount. Historically, the design and development of crankshafts relied on empirical methods and simplified analytical approaches. However, the advent of computational tools has ushered in a new era, allowing for more accurate and sophisticated analyses. ANSYS, a leading finite element analysis (FEA) software, has emerged as a versatile platform for simulating and optimizing complex mechanical systems, including crankshafts. This review aims to provide a comprehensive overview of the current state of crankshaft analysis and modeling, focusing specifically on the utilization of ANSYS software. The integration of ANSYS in the design process facilitates a deeper understanding of the mechanical behavior of crankshafts under various operating conditions. By exploring the capabilities of ANSYS in structural analysis, fatigue life prediction, and design optimization, this paper aims to elucidate the advancements and challenges associated with incorporating this powerful software in crankshaft development, as shown in figure 1.

Figure 1 Simple Crank Shaft

2. LITERATURE REVIEW

Literature reviews are integral components of academic research papers, theses, dissertations, and scholarly articles. They serve to situate the research within the existing body of knowledge, demonstrate the researcher's familiarity with prior work, and justify the need for new investigations.

Sujata et. al. (2021) The stress analyses of a single-cylinder crankshaft are discussed using finite element method in this paper. Three-dimension models of single crankshaft and crank throw were created exploitation Pro/ENGINEER package.

The finite element analysis (FEM) software system ANSYS was won't to analyze. Result shows that FEA Results matches with the theoretical calculation therefore we will say that FEA may be a good tool to reduce time overwhelming theoretical Work. The most deformation seems at the middle of crankpin neck surface. The most stress seems at the fillets between the crankshaft journal and crank cheeks and close to the central purpose Journal.[11]

Pawar et al. (2021) offers a summary of RP technology in short-term and stresses on their capacity to reduce the product design and development process. Classification of RP processes and details of few important processes is given. The description of various stages of data preparation and model building has been presented.

An attempt has been created to incorporate some necessary factors to be thought-about before beginning part deposition for correct utilization of potentials of RP processes. Speedy prototyping won't build machining obsolete, however rather complement it.[12]

Marchesi et al. (2021) research is a first step towards an effective application of topology optimization and additive manufacturing for the diesel engine support. As future work, the confirmation that the additively manufactured and topologically optimized part can replace the original one is a must. This example shows that topological optimization and additive manufacturing have great potential to replace conventional design and manufacturing processes.[13]

Baragetti et.al. (2021) Useful criteria for the design of high-power engines crankshaft have been reported in this paper. Numerical models were developed. The experimental evaluation of some parameters, such as the damping coefficient, needed to be determined in order safely verifies the resistance of the crankshaft. The procedure can be extended to any other kind of crankshafts. [14]

Gill et al. (2021) a dynamic simulation was showed on a crankshaft for a single cylinder four stroke camless Engine. Finite element analysis was achieved to gain the variation of stress amount at serious locations. The maximum load ensues at the crank angle of 352 degrees for this specific engine. At this angle only bending load is useful to the crankshaft.[15]

Prasad et. al. (2021) studied a cast iron crankshaft of one cylinder four –stroke ICE was taken and a static analysis was conducted to induce variation of stress magnitude at essential locations of the crankshaft. A model was created in CATIA of crank shaft and foreign into ANSYS to carryout static analysis.

Meshing of crankshaft was done; hundreds and boundary conditions were applied as per the mounting conditions of the crankshaft on Finite component model of crankshaft. Results obtained from the analysis were then employed in optimization of the cast iron shaft. Weight improvement is achieved by variable the crankpin diameter. [16]

Singh et al. (2020) said that Dynamic FEA could be a smart tool reduces pricey experimental work. By observant the static analysis results shows that stress assesses exploitation nickel stainless steel and steel crank shafts from one cylinder four stroke engine are at intervals the permissible stress price.

Thus, using nickel stainless steel and steel is good for crank shafts however as compared between nickel chrome and steel, nickel chrome is best suited material over the steel.[17]

Ravi Kumar Goel et. al. (2020) On the idea of this studies performed, it will be all over that the planning parameter of rod will be changed in such the way in order that sufficient improvement within the existing results will be obtained. Throughout the planning improvement, weight of the crankshaft is additionally reduced by 193 gm which ends in reduction in inertia and centrifugal forces. It had been found that the utmost stress purpose region was at the knuckle of the center main journal shaft and crank arm.[18]

Kütük et. al. (2020) a new algorithm is developed for topology optimization of 3D machine parts. Validity of the algorithm is proved by means of simple beam parts and two parts from industrial application.

The results of the comparisons imply that the element removal algorithm can be safely used for 3D machine parts. Also, solution times are compared with ANSYS and up to 75%-time reduction is obtained by using the element removal algorithm. When the stress and deformation results are compared, up to 50% reduction can be obtained depending on the boundary conditions in the ERM results.[19]

Khatawate et. al. (2020) presents results of strength analysis done on crankshaft of one cylinder 2 stroke petrol engine, to optimize its style, using PRO/E and ANSYS code. The 3-dimensional model of crankshaft was developed in PRO/E and imported to ANSYS for strength analysis. The crankshaft was found to be over dimensioned. so, web thickness was reduced from 13 millimetre to 10 millimetre. The reduction in mass obtained by this style modification is: Mass Reduction = 1.9725 kilo - 1.6375 kilo = 0.335 kilo percentage Mass Reduction = 16.98%. [20]

Problem Formulation:

Due to the inherent high density of ferrous materials traditionally used in crankshaft manufacturing, the resulting crankshafts tend to be bulky. This bulkiness contributes to an increase in the overall weight of the engine. In light of this, there is a need to explore alternative materials that can effectively reduce the weight of the crankshaft while maintaining essential material properties.

Objectives:

The following as under

- To reduce the overall weight of crankshaft implementing the new optimised design.
- To compare the existing crankshaft design with new optimised design in terms of obtained von-mises stress and deformation.
- To compare the weight of conventional crankshaft with new optimised design model.

3. METHODOLOGY

Proposed methodology to be adopted while performing the design, optimization and analysis on crankshaft design: Computer Aided Design gives point by point data on Computer Aided Design, Computer Aided Design Software, Computer Aided Design and Manufacturing, Computer Aided Design and Engineering and that's just the beginning. Computer Aided Design is associated with Cam and Computer Aided Design. In light of the idea of CAD innovation, numerous CAD programming have been created by programming goliaths like Auto-work area Inc, Bentley, Dassult Systemes, some of the main programming in the business are Auto-CAD, SOLIDWORKS, CATIA, Pro-Engineer, Uni-designs, Solid-Edge, STAAD Pro, Auto-Civil, Auto-work area Inventor and the rundown continues forever. Because of CAD offices, the reiteration of work is limited, precise exactness can be accomplished; propagation isn't an issue now days.

After change into computerized position, it can likewise be sent through electronic mail to any piece of the world as an editable document. Because of accessibility of a great deal of record designs, a similar document can be opened and utilized in an assortment of CAD programming. CATIA is an abbreviation for Computer Aided Three-dimensional Interactive Application. It is one of the main 3D programming utilized by associations in various businesses extending from aviation, vehicle to customer items.

4. CONCLUSION

In conclusion, the integration of ANSYS software in the design and development of crankshafts represents a significant stride towards achieving higher efficiency, reliability, and performance in internal combustion engines. The review has highlighted the pivotal role played by ANSYS in structural assessments, fatigue life predictions, and design optimization processes, demonstrating its versatility in addressing key challenges associated with crankshaft technology. As we continue to advance in computational capabilities, the synergy between ANSYS and crankshaft development is poised to drive further innovations, paving the way for more sustainable and high-performing internal combustion engines in the future.

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