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DESIGN AND FEA ANALYSIS OF A FASTENER USING V GROOVE FOR FAN ASSEMBLY TO AVOID ACCIDENTS

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ABSTRACT :

The major purpose of this project is to improve the safety and reliability of fan assemblies by designing and conducting finite element analysis (FEA) on a new fastener with a V-groove mechanism. Traditional attaching methods for fan assemblies frequently create security and durability issues, potentially resulting in accidents due to loosening or failure over time. To address this issue, this project presents a new fastener design with a V-groove configuration to enable a more robust and secure connection between fan components. This design tries to reduce the risks associated with vibrational and rotational loads, which are typical in fan operations and can cause fastener loosening or failure. The project uses cutting-edge FEA techniques to test the performance of the proposed V-groove fastener under a variety of settings, including load scenarios and environmental considerations. Through these simulations, the study investigates the fastener's capacity to maintain a secure connection, resist wear, and extend the operating life of the fan assembly. The analysis focuses on critical performance characteristics like stress distribution, deformation, and potential failure spots, which provide information about the fastener's usefulness

in improving fan safety and durability.

KEYWORDS – V groove fastener, Finite Element Analysis (FEA), fan assembly, safety, mechanical behavior, dependability, novel design, and accident prevention.

INTRODUCTION:

PROBLEM STATEMENT:

Many fan assemblies rely on fasteners to keep blades secure. These conventional fasteners can loosen or break under strain, resulting in major mishaps if the blades detach or the fan becomes imbalanced. This project intends to increase safety by designing and testing a fastener with a V-groove mechanism. This novel design offers a stronger grip and greater resistance to stress, thereby minimizing accidents and lowering maintenance requirements. We will use FEA tools to examine the fastener's performance in real-world situations and optimize the V-groove for optimal security. The ultimate goal is to develop a fastener that considerably lowers the likelihood of accidents caused by fan assembly failures.

OBJECTIVE:

The primary goal of this project is to create a new fastener designed exclusively for fan assembly, combining modern engineering ideas and materials to drastically reduce the danger of accidents. The project's goal is to improve the fastener's mechanical integrity while also making installation and maintenance easier.

SCOPE:

The goal of this project is to create and test a unique V-grooved fastener that will increase fan assembly safety. We will carefully design the fastener to be compatible with existing fan components, taking into account factors such as material selection and V-groove shape optimization. FEA software will be used to model the fastener's performance under real-world stresses such as centrifugal forces and vibrations. The analysis will look at stress distribution, potential deformation, and the efficiency of the V-groove in preventing failure. Based on these findings, we will improve the design and do additional FEA simulations. The project will provide complete engineering drawings, FEA studies, and findings on the effectiveness of the V-groove design. While physical prototypes and real-world testing are out of the scope, this project intends to build a well-defined and optimized V-grooved fastener with the potential to significantly improve fan assembly safety.

LITERATURE REVIEW :

- **Three-dimensional finite element analysis of threaded fastener loosening due to dynamic shear load by Niranjan Pai , D.P. Hess**

This study looks at how vibration from dynamic shear loads loosens threaded fasteners. While fatigue and loosening are well-known issues, this article focuses on loosening caused by thread and fastener head slippage. The researchers created a 3D finite element model to investigate various loosening scenarios and slip-related parameters. Notably, the model predicts loosening at unusually low shear stresses due to localized slip.

- **Fatigue failure analysis of holding U-bolts of a cooling fan blade by Mohsen Reihanian, K. Sherafatnia, M. Sajjadnejad**

  Researchers examined a broken U-bolt from a cooling fan and confirmed fatigue as the cause. They employed specialized tools to evaluate the fracture and computer modeling to determine the stresses on the bolt. The study revealed that the bolts were undergoing complicated stress (multiaxial fatigue) and indicated weak areas. They even anticipated the bolts' fatigue life (3.63 million cycles).

- **Investigation of Strength of Bolted Joint by Using FEA by Mr.R.M.Deshmane**

This research proposes various array configurations for investigating the shear strength of bolted joints often utilized in industry. Catia and FEM modeling tools were used to create 3D models of bolted joints with varying array patterns. Proposed FEA tools and approaches aim to improve bolted joint performance.

- **A Comparative Study of Joint Modeling Methods and Analysis of Fasteners by Ricardo Garcia, Michael Ross, Benjamin Pacini, Daniel Roettgen**

Designing strong joints for dynamic circumstances is critical. This research assists in selecting the appropriate fastener model during the design process. There are three primary options: springs, beams, and solid elements. If you're concerned about the stress on the parts being linked, use the Ring Method. However, if the fastener's strength is your primary concern, the Spring Method is preferable.

- **Research on Anti-loosening Performance of Screw with V-shaped Thread Based on FEA by Xiaobo Li, et al.**

This paper investigates the anti-loosening performance of screws with V-shaped threads using FEA. It investigates the impact of V-groove geometry parameters (angle and depth) on the locking effect and stress distribution. The findings can help you optimize your fastener's V- groove design for fan assembly.

- **A Novel finite element for modeling a fastener in a laptop joint assembly by Brian D. Foster**

  Researchers developed a new method for analyzing bolted lap joints under tension. This method is faster and more precise than previous methods, although it is limited to certain conditions. It is ideally suited for joints with little bending and consistent materials throughout. The secret weapon Including a unique contact mechanics theory to better mimic how the bolt presses on the linked parts.

METHODOLOGY:

Our project will provide a secure V-grooved fastening design for fan assemblies. First,we'll specify the fan's specifications, including blade size, material, and operatingcircumstances. We'll then use CAD software to design the fastener in 3D, with an emphasison V-groove geometry, material selection for strength and weight, and compatibility withexisting parts. FEA software will be used to generate a digital model of the fastener and its surrounding components. We'll specify the materials' properties and simulatevarious loads that the fastener may encounter during operation, such as centrifugal forcesand vibrations. We'll use FEA simulations to investigate stress distribution, possibledeformation, and the V-groove's efficiency in avoiding loosening. If the original designfulfills performance targets, we will move forward with it.

If not, we will fine-tune the V-groove and repeat the analysis until optimal performance is reached. Finally, we will provide full engineering drawings and FEAreports that demonstrate the analysis method, results, and design optimization. This methodology ensures a well-designed and secure V-grooved fastening, resulting in safer and more dependable fan assemblies.

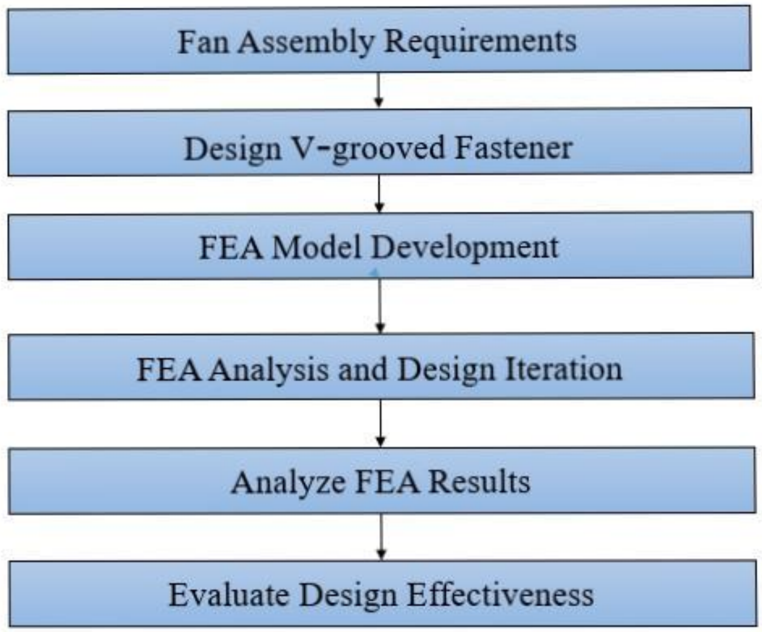


Fig – 1 Schematic Diagram

SIGNIFICANCE:

The project "Design and FEA Analysis of a Fastener for a Fan Assembly to AvoidAccidents" addresses an important element of fan safety. This project seeks to avoidmishaps caused by fan detachment or malfunction by inventing a strong and dependablefastening. This not only improves safety, but it also increases fan efficiency by assuring a reliable connection. This leads to improved performance, reduced energy usage, and,eventually, lower operational expenses. Furthermore, the project employs FEA, apowerful technique for calculating stress and strain on fasteners. This enables engineers to design a more reliable fastener with a lower failure rate, resulting in safer, more efficient, and cost-effective fan assemblies.

PROBLEM IDENTIFICATION:

Conventional fasteners in fan assembly can provide a problem. In the worst-case situation, a loose fastener could cause a blade to detach, endangering people or damaging equipment. Even if a blade does not fully detach, a loose fastener can cause the fan to become imbalanced, resulting in vibrations, decreased performance, and a shorter lifespan. These challenges are caused by vibrations during operation, thermal expansion and contraction, or just not tightening the fastener enough at first. This project suggests a novel solution: a V-grooved fastening. The V-groove

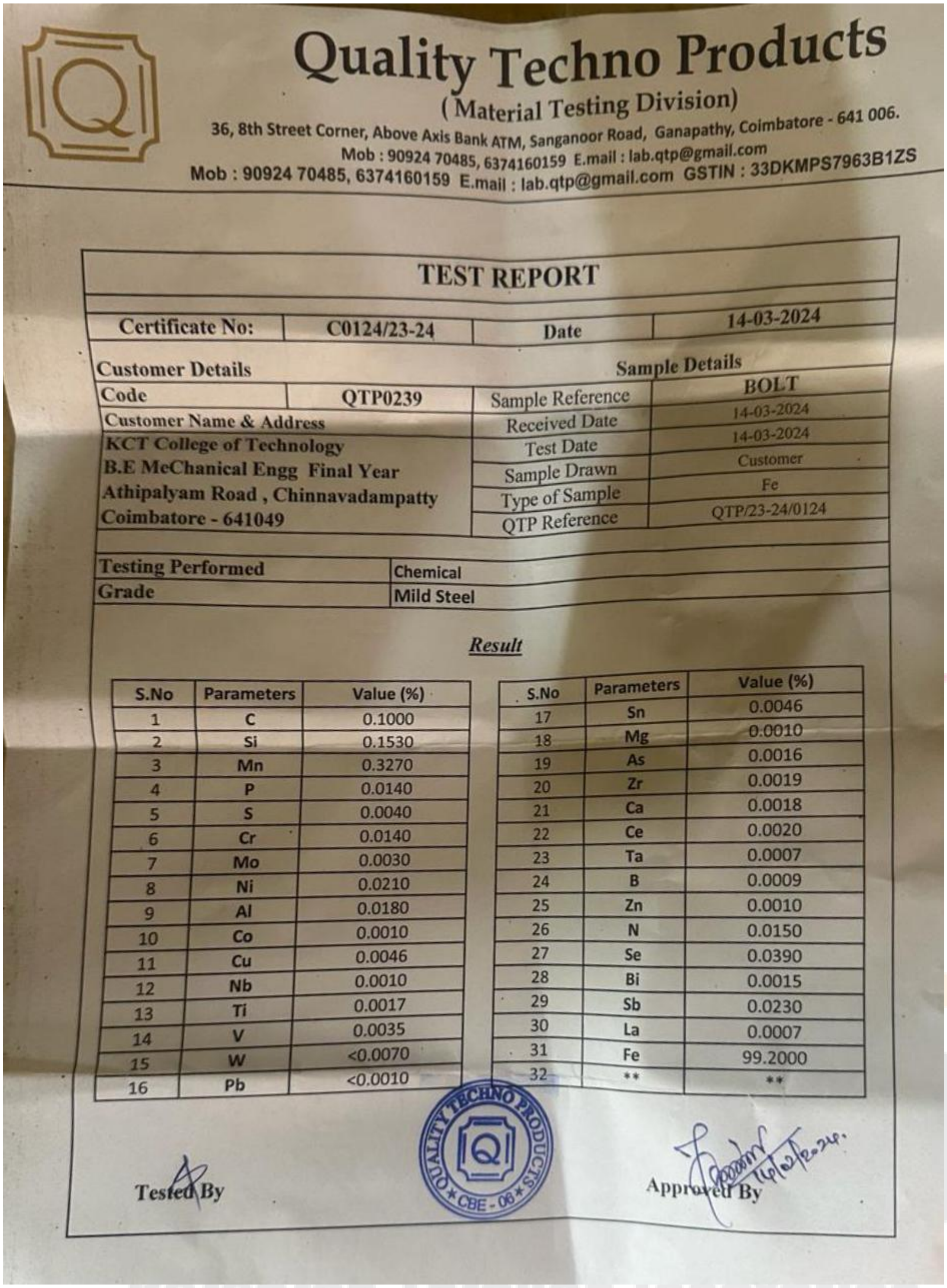
design aims for a firmer grip and greater resistance to loosening than standard fastener. Insome circumstances, the V-groove may obviate the requirement for additional lock washers. We intend to develop a safer and more dependable method of securing fan blades and preventing accidents entirely by optimizing this V-grooved fastener design using FEA analysis

MATERIAL SELECTION:

Material – MILD STEEL

Material selection is one the crucial part of a component. Mild steel's low cost and superior machinability make it an appealing choice for the V-grooved fastener. However, we must balance its limitations. While mild steel is simple to work with and inexpensive, it is not the most durable alternative. This could be a concern with high-stress fan assembly. Furthermore, mild steel rusts rapidly, particularly in humid areas, which can erode the fastener over time. Mild steel may be suitable if the fan assembly runs in a dry environment with mild loads and the design adjusts for its lower strength. However, for emphasizing safety or durability in possibly damp situations, high-strength steel alloys or corrosion-resistant materials such as stainless steel would be a better option.

FEA analysis will be required to definitively determine whether mild steel can withstand the expected stress and whether the V-groove design with this material provides adequate holding force. Finally, while mild steel has its benefits, we may need to prioritize stronger and more



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TEST REPORT

Certificate No:	C0124/23-24	Date	14-03-2024

Customer Details		Sample Details	
Code	QTP0239	Sample Reference	BOLT
Customer Name & Address		Received Date	14-03-2024
KCT College of Technology B.E MeChanical Engg Final Year Athipalyam Road , Chinnavadampatty Coimbatore - 641049		Test Date	14-03-2024
		Sample Drawn	Customer
		Type of Sample	Fe
		QTP Reference	QTP/23-24/0124

Testing Performed	Chemical
Grade	Mild Steel

Result

S.No	Parameters	Value (%)	S.No	Parameters	Value (%)
1	C	0.1000	17	Sn	0.0046
2	Si	0.1530	18	Mg	0.0010
3	Mn	0.3270	19	As	0.0016
4	P	0.0140	20	Zr	0.0019
5	S	0.0040	21	Ca	0.0018
6	Cr	0.0140	22	Ce	0.0020
7	Mo	0.0030	23	Ta	0.0007
8	Ni	0.0210	24	B	0.0009
9	Al	0.0180	25	Zn	0.0010
10	Co	0.0010	26	N	0.0150
11	Cu	0.0046	27	Se	0.0390
12	Nb	0.0010	28	Bi	0.0015
13	Ti	0.0017	29	Sb	0.0230
14	V	0.0035	30	La	0.0007
15	W	<0.0070	31	Fe	99.2000
16	Pb	<0.0010	32	**	**

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corrosion-resistant materials for safety-critical fan assembly applications.

Fig 2 - Material Testing

BOLT DESIGN :

Designing and conducting Finite Element Analysis (FEA) of an M12 bolt with a V groove for a fan assembly is a forward-thinking way to improve safety and reliability in mechanical designs. This brief review will walk you through the necessary procedures for modeling, simulating, and analyzing such a bolt in ANSYS, using the project title “Design and FEA analysis of a fastener using V groove for fan assembly to avoid accidents”. The basic dimensions of a bolt vary according to the measurement system used. Bolts in metric systems (ISO) are identified by a “M” followed by a number denoting the nominal diameter of the shaft in millimeters (e.g., M12). Thread pitch, which is the space between threads, may be used to specify compatibility. Imperial systems employ diameter and threads per inch (TPI) for bigger bolts and a numbering system for smaller ones. Head type and length are independent criteria. When selecting a bolt, consider the application, material, and standards such as ISO or ANSI .

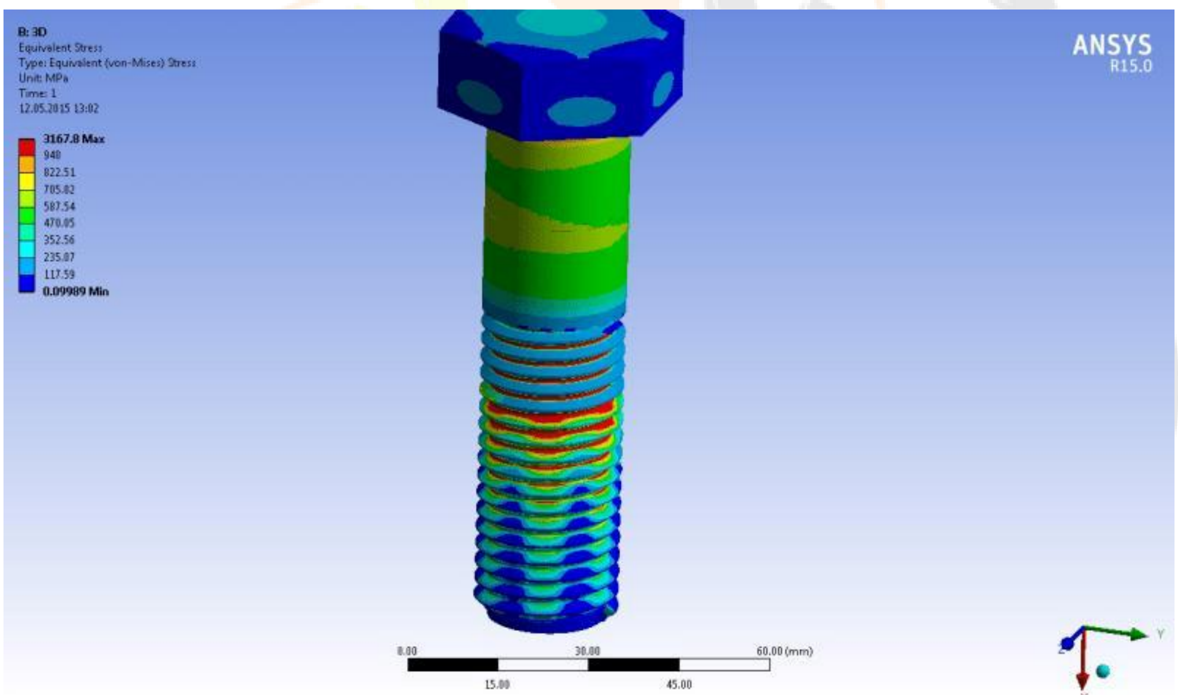
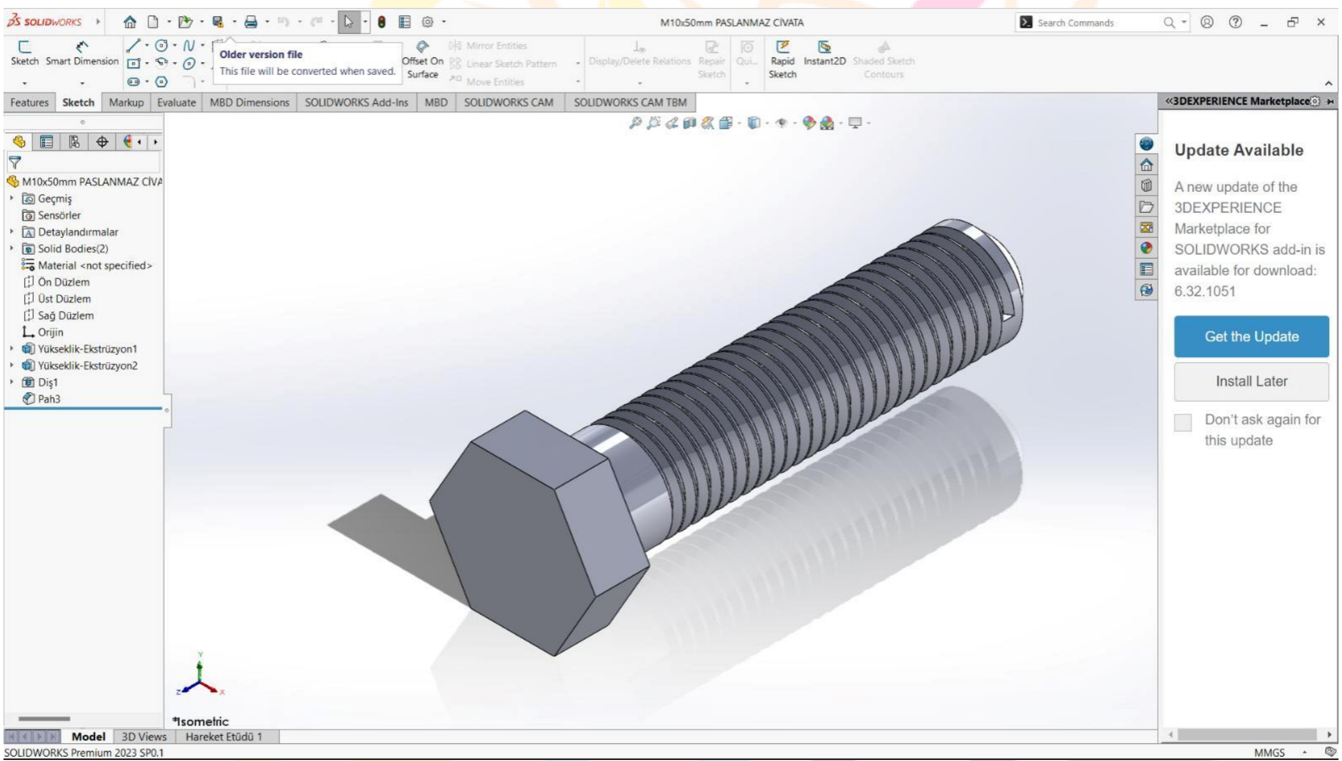


Fig 3 – M12 Bolt Ansys Stress Analysis

EXISTING SOLUTION :

Traditional fan assembly rely on fasteners such as bolts, nuts, and quick-release pins. While these provide some protection, they can loosen owing to vibrations or require extra components such as locknuts or thread-locking glue, which adds complexity. Existing self-locking fasteners provide some improvement, but their performance is uneven. These constraints highlight the need for a more secure approach to reduce the risk of accidents caused by fastener failure in fan assembly.

Fig 4 - M12 Bolt Solidworks Design



PROPOSED SOLUTION:

Existing fan assembly fasteners have limitations. This project introduces a novel solution: a fastener with a V-groove mechanism. This unique design aims for a firmergrip between the fastener and the components than standard designs. The V-groove would function as a locking mechanism, potentially eliminating unnecessary parts and lowering assembly complexity. The V-groove's engagement could also be visually verified for a rapidsafety check. Using FEA software to analyze this design, we can evaluate its performance under real-world situations and tweak the V-groove for maximum security. This project intends to develop a fastener that greatly improves upon existing fan assembly safety solutions.

Fig 5 - After V- groove M12 Bolt

CHARACTERISTICS:

The V-grooved fastener for this project is intended to be a game changer in fan assembly safety. Strength and durability are critical, ensuring that the fastener can endure a varietyof stresses while keeping blades securely attached. The V-groove is important because it provides a firmer grip and is more resistant to loosening than standard flat surfaces. Ideally, the V-groove would eliminate the need for additional parts such as lock washers, making assembly easier and decreasing human error. A visual confirmation that the V-groove is engaged during installation would be useful. Of course, the design must integrate easily with current fan components while keeping weight in mind for balanced operation. Finally, the material and design should be simple to machine and manufacture for thecost-effectiveness.

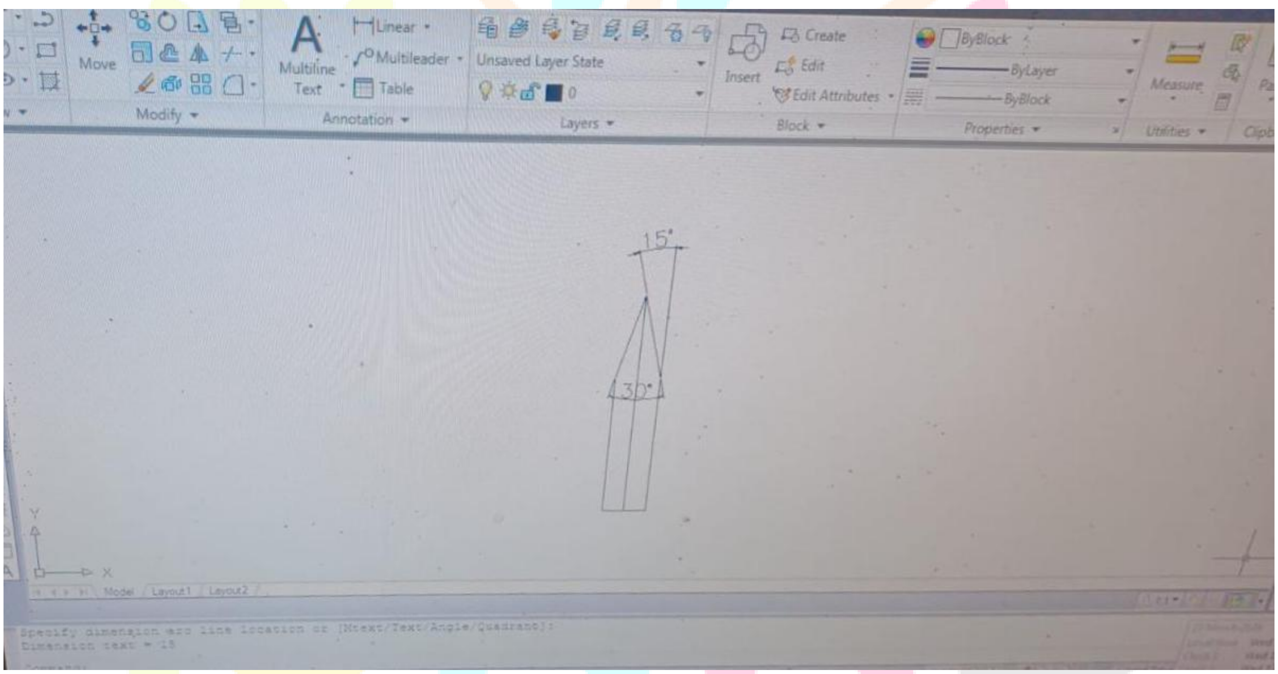


Fig 6 –   Basic 2D Drawing in AutoCAD

DIFFERENT PARAMETERS:

When designing and analyzing a safe V-grooved fastener for fan assemblies, numerous criteria must be considered. First, we need information about the fan itself, such as blade size, material, and operating speed. This allows us to better understand the forces acting on the fastener. The material and design of the hub/housing are also essential since they affect how well the fastener is held.

The V-groove design is key. To ensure a secure grip, we will adjust the groove angle, depth, and width. Choosing the appropriate fastener material requires a delicate balance of strength, weight, corrosion resistance, and cost-effective manufacture. Thread type, dimensions, and overall fastener size all need to be compatible with the present fan assembly.

Fig 7 – Measuring Degree Protractor

FABRICATION PROCESS:

While FEA analysis is important, we cannot disregard how the V-grooved fastener will be manufactured. To ensure cost-effective production, the material must be easily machined. Complex V-groove designs may be possible, although simpler shapes may be better suited for operations such as cold forging or thread rolling, particularly if they match performance criteria. The design should be optimized for manufacturability, taking into account production volume and turnaround time. A smooth and exact V-groove finish is required for a secure fit, therefore quality control is critical throughout fabrication.

Depending on the material, heat treatment or hardening may be required to increase strength and wear resistance. FEA analysis can help influence fabrication decisions. If the investigation indicates that a simpler V-groove performs well, it may be advantageous from a manufacturing perspective. Here are a few possible fabrication methods: CNC machining for intricate designs or prototypes, thread rolling or cold forging for simpler grooves and high volume manufacturing, and screw machining to strike a balance between complexity and efficiency. Environmental impact and worker safety during fabrication are both essential factors. Thinking about how the fastener will be created throughout the design phase allows us to ensure that it is not only functional and safe, but also manufacturable utilizing cost-effective and dependable techniques.

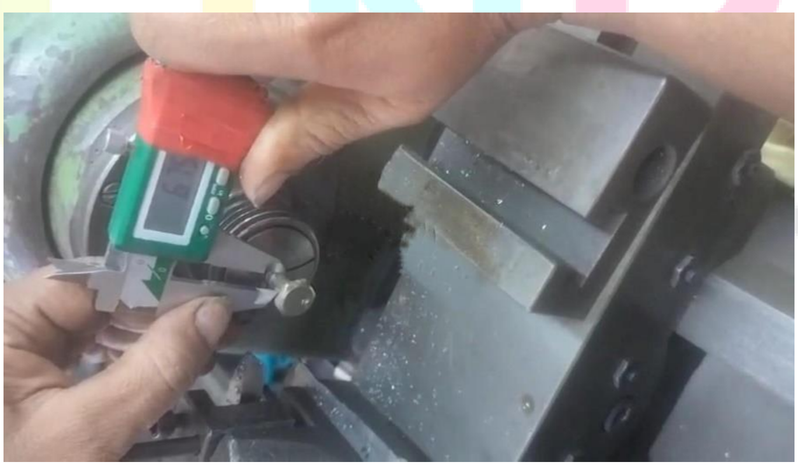


Fig – 8 Fabricated Workpiece

RESULT:

The Ansys FEA analysis should provide valuable information on the safety of the V grooved M12 bolt specified for your fan assembly. The findings will most likely center on stress distribution, particularly around the V-groove. The goal is to keep stresses below the material's yield strength to avoid irreversible damage or breaking. The research will also look at strain levels and deflections under load. Strain should be kept within the elastic limit to prevent jeopardizing the bolt's ability to recover to its original shape. To ensure proper fan functioning, deflection should be kept to a minimum. Finally, We can confirm the accuracy of your design by comparing FEA findings to analytical calculations or experimental data, if available.

Fig – 9 Breaking of M12 Bolt

DISCUSSION:

The FEA analysis supports the idea that the V-groove fastener provides a better mechanical bond within fan assemblies, greatly lowering the probability of accidents caused by fastener failure. The equal distribution of stress and increased load-bearing capability demonstrate the design's potential to improve fan assembly safety standards.

However, it is critical to consider the production challenges and costs connected with implementing the V-groove design. While the research yields encouraging findings, the feasibility of mass manufacturing, material selection, and cost-effectiveness will be critical factors in the design's adoption in industrial applications.

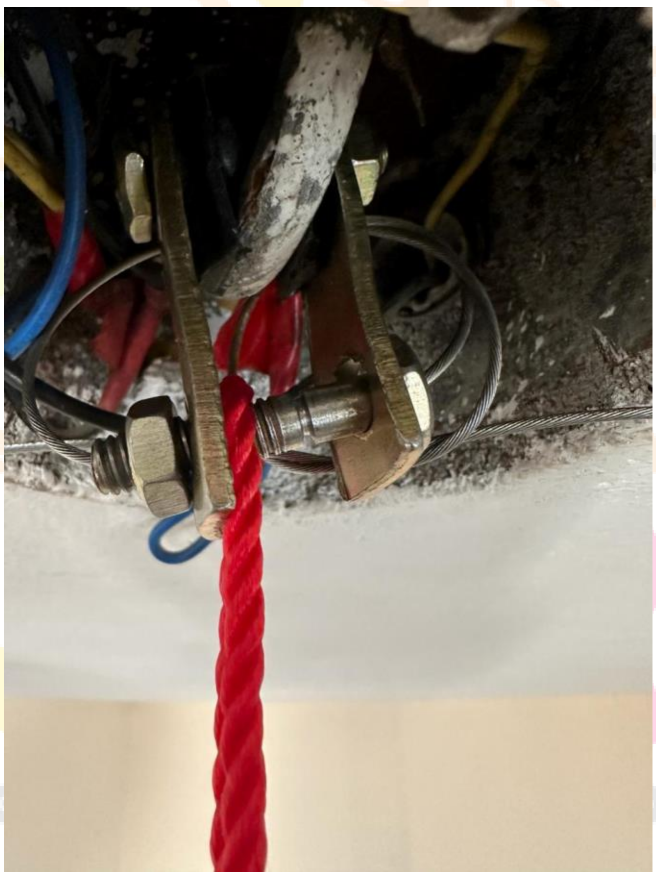


Fig – 10 M12 Bolt connected with Fan top

CONCLUSION:

The project effectively illustrates that designing and analyzing a fastener with a V-groove for a fan assembly can greatly improve assembly safety by reducing the possibility of accidents caused by fastener failure. Future work should focus on optimizing the design for simplicity of manufacture and cost reduction, as well as real-world testing to validate the FEA results and optimize the fastener design. This research serves as a testament to the potential of technical innovation in greatly enhancing product safety and preventing accidents, marking a huge step forward towards safer mechanical design practices.

Finally, the initiative not only met its basic goals, but also paved the way for future research. The V-groove fastener design, proven by thorough FEA testing, offers a promising alternative for increasing the safety and integrity of fan assemblies. Future study could include looking at the use of this design in various mechanical systems, optimizing material choices, and conducting real-world testing to completely validate its effectiveness and feasibility for wider use.

Fig – 11 M12 Bolt EDM Process

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