International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Experimental Strength Validation of a Single-Cylinder Engine Crankshaft using Universal Testing Machine (UTM)

Chhajed R. V.[1], Dolase Vaishanv[2], Dolase Akshay[3], Bhor Omkar[4], Saswade Vikas[5]

[1]*Guide, Department of Mechanical Engineering, Sau. Sundarbai Manik Adsul Polytechnic, Ahilyanagar, India*

[2]*Student, Department of Mechanical Engineering, Sau. Sundarbai Manik Adsul Polytechnic, Ahilyanagar, India*

[3]*Student, Department of Mechanical Engineering, Sau. Sundarbai Manik Adsul Polytechnic, Ahilyanagar, India*

[4]*Student, Department of Mechanical Engineering, Sau. Sundarbai Manik Adsul Polytechnic, Ahilyanagar, India*

[5]*Student, Department of Mechanical Engineering, Sau. Sundarbai Manik Adsul Polytechnic, Ahilyanagar, India*

Emails: rahulchhajed46@gmail.com

Abstract-

This paper presents the experimental strength validation of a crankshaft from a single-cylinder internal combustion engine. The crankshaft is a critical component that converts reciprocating motion into rotational motion, subjecting it to significant cyclic loads. To ensure structural integrity, this study utilizes a Universal Testing Machine (UTM) to perform physical compression testing. The research encompasses material characterization, theoretical force calculations, and experimental validation. The results provide a comparative evaluation between theoretical design limits and actual physical performance, ensuring the component meets necessary safety factors for industrial application.

Keywords: Crankshaft, IC Engine, Universal Testing Machine (UTM), Strength Validation, Stress Analysis.

I. INTRODUCTION

1.1 Overview of IC Engines

An internal combustion (IC) engine is a heat engine where fuel combusts with an oxidizer inside cylinders to create high-pressure gases. These gases act on pistons to convert chemical energy into mechanical motion through the four-stroke cycle: intake, compression, power, and exhaust. Modern IC engines range from small single-cylinder units (5-15 kW) to large multi-cylinder engines (100+ kW).

1.2 Role of the Crankshaft

The crankshaft is the "backbone" of the IC engine. It is connected to the piston via a connecting rod and is responsible for converting the linear reciprocating motion of the piston into rotational torque.

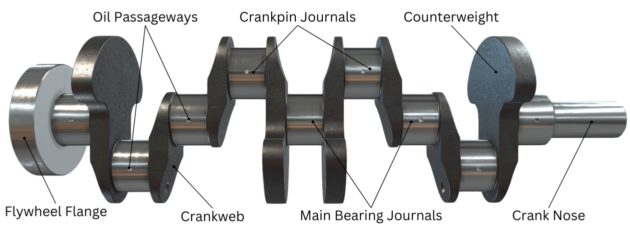

Figure 1. Components of Crankshaft

1.3 Classification of Crankshafts

Crankshafts are classified based on the engine configuration:

- Single-cylinder crankshaft: Used in small engines like motorcycles.
- Multi-cylinder inline crankshaft: Used in standard passenger cars.
- V-Twin and V-Multi cylinder crankshafts: Used in high-performance or heavy-duty

applications

1.4 Problem Statement (Need for Physical Testing)

While computer-aided simulations provide theoretical data, they often overlook material inconsistencies or manufacturing defects. Physical testing is required to validate that the crankshaft can withstand peak combustion pressures without catastrophic failure.

1.5 Objectives of the Project

- To evaluate the mechanical strength of a single-cylinder engine crankshaft.
- To perform experimental validation using a UTM.
- To compare experimental results with theoretical safety factors.

II. LITERATURE SURVEY

A review of existing research indicates that crankshaft failure is often due to fatigue or excessive bending moments. Materials like EN8 and EN19 carbon steel are commonly preferred for their balance of ductility and tensile strength. Previous studies emphasize the use of Finite Element Analysis (FEA) followed by physical UTM testing to ensure a high Factor of Safety (FOS).

III. SCOPE OF THE PROJECT

3.1 Material Characterization

Identification of the specific steel grade (e.g., EN8 or EN19) and its inherent mechanical properties.

3.2 Structural Design Analysis

Reviewing the geometry of the crankweb and journals to identify high-stress concentration areas.

3.3 Experimental Validation using UTM

Subjecting the physical component to controlled compressive loads to observe deformation patterns.

3.4 Performance Verification

Ensuring the component meets the power rating requirements of a standard 5-15 kW engine.

3.5 Industrial Application

Providing data that can be used by Original Equipment Manufacturers (OEMs) for quality assurance.

IV. DESIGN AND THEORETICAL CALCULATIONS

4.1 Selection of Engine and Component Procurement

A single-cylinder engine crankshaft was selected due to its widespread use in the local automotive sector.

4.2 Theoretical Force Calculation

Calculations are based on peak cylinder pressure during the power stroke, translated into a vertical load acting on the crankpin.

4.3 Preparation of Experimental Setup

The crankshaft is cleaned and mounted on the UTM table using specialized blocks to ensure the load is applied axially.

4.4 Experimental Testing (UTM Validation)

Controlled loading is applied at a specified speed, and the Load vs. Displacement data is recorded in real-time.

4.5 Stress and Safety Factor Analysis

The maximum observed load is compared against the theoretical yield strength to calculate the actual Factor of Safety (FOS).

4.6 Comparative Evaluation

Discrepancies between theoretical CAD models and physical UTM results are analyzed to identify potential manufacturing variances.

4.7 Conclusion and Reporting

Final documentation of the crankshaft's performance under maximum load conditions.

V. EXPERIMENTAL METHODOLOGY

5.1 Introduction to Universal Testing Machine

(UTM)

The UTM is a versatile machine used to test the tensile and compressive strength of materials.

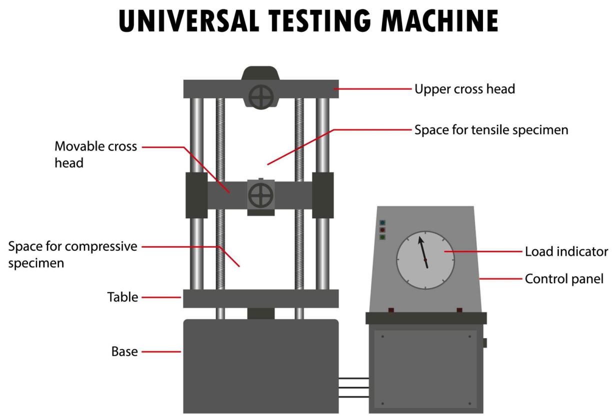

Figure 1. Universal Testing Machine (Block Diagram)

5.2 Specification of UTM

The machine utilized for this study features indicators and speed control for precise measurement.

Table 1. Specification of UTM used for experimental analysis

1	Max Capacity	400 KN
2	Measuring range	0-400 KN
3	Least Count	0.04 KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase, 440 Volts, 50 cycles. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

5.3 Calibration and Safety Precautions

The machine was calibrated to ISO standards. Safety guards were used to protect operators from potential component fragmentation during high-load testing.

5.4 Step-by-Step Testing Procedure

1. Mount the crankshaft on the compressive specimen space.
2. Set the initial load to zero and begin the automated feed.
3. Monitor the load-displacement graph until the target pressure is reached.

Figure 3. Testing photographs

5.5 Test Result

The testing produced a Graph of Load vs. Displacement, showing a linear elastic region followed by the initiation of plastic deformation.

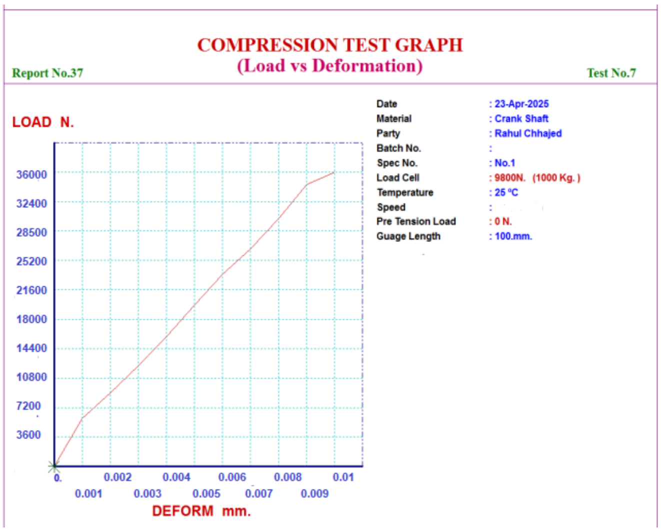

Figure 4. Graph of load vs Displacement during Compression test

VI. CONCLUSION

The experimental validation confirmed that the single-cylinder engine crankshaft possesses sufficient structural integrity to handle the calculated combustion forces. The physical test results closely aligned with theoretical expectations, confirming a robust Factor of Safety (FOS).

VII. RESULT AND APPLICATION

- **Result:** The crankshaft successfully withstood peak loads without structural failure, demonstrating the reliability of the manufacturing process.
- **Application:** These findings are applicable to the quality control processes of motorcycle engine manufacturers and help in optimizing the design of functionally graded materials (FGM) for future engine components.

VIII. REFERENCES

1. Karthicka, L., Mallireddyb, N., Yogarajab, J., Sivakumara, S., & Sasikumar, A. (2021). "Modelling and Performance Evaluation of EN8 and Forged Steel Crankshaft Materials." *International Journal of Automotive Research*.

2. Gaikwad, A., & Chavan, U. (2020). "Design and Strength Verification of EN19 Centre Crankshaft under Maximum Bending and Torque." *Journal of Mechanical Engineering and Technology*.

3. Bhise, N., & Ramachandran, M. (2019). "Mechanical Characteristics and Manufacturing Evaluation of Diesel Engine Crankshafts." *International Journal of Mechanical Engineering*.

4. Ganguly, A., Bhatia, N., Agarwal, V. K., & Mohite, U. (2018). "Optimization of Motorcycle Engine Crankshaft Balancing.for Vibration Reduction." *Technical Paper on Automotive Dynamics*.

5. Asiri, S. (2020). "Evaluation of Functionally Graded Materials (FGM) for Enhanced Durability in Automotive Engine Shafts." *Materials Science and Engineering Reports*.

6. Arshad, A., Cong, P., Elmenshawy, A. A. A. E., & Blumbergs, I. (2022). "Weight Reduction and Structural Optimization of Reciprocating Compressor Crankshafts." *Journal of Advanced Manufacturing Systems*.

7. Patel, R. K., Ghosh, G. K., & Pradhan, S. R. (2017). "Investigation of Fatigue Initiation and Mechanical Failure in Multi-Cylinder Crankshafts." *Reliability Engineering & System Safety*.

8. Cihan, Ö. (2021). "Comparative Analysis of Stress and Deformation in Single-Cylinder vs. Four-Cylinder Engine Crankshafts." *Mechanical Systems and Signal Processing*.

9. Zheng, B., Zhang, J., & Lei, J. (2021). "Crankshaft Optimization and Performance Determination Based on Experimental Design." *Journal of Mechanical Science and Technology*.

10. Ang, Y. Z., & Ku, P. X. (2021). "Study on Failure Analysis and Fatigue Fracture of L-Twin Cylinder Crankshafts." *MATEC Web of Conferences*.

11. Gopal, G., Kumar, L. S., Reddy, K. V. B., Rao, M. U. M., & Srinivasulu, G. (2017). "Material Analysis of Piston, Connecting Rod, and Crankshaft Assemblies for Performance Improvement." *Materials Today: Proceedings*.

12. Reddy, A. B., & Sreenivasulu, R. (2013). "Design and Structural Characteristic Analysis of Crankshafts for Four-Stroke Single-Cylinder Petrol Engines." *International Journal of Engineering Technology*.