Journal of Automotive Engineering Technology

ISSN (Print) XXXX-XXXX ISSN (Online) XXXX-XXXX

Jig and Fixture Design for Motorcycle Engine Mounting Based on the Pro Table Kit System

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ARTICLE INFO

Received : 27 July 2025
Revised : 4 August 2025
Accepted : 30 November 2025

KEYWORDS

Jig & Fixture, Engine Mounting, Pro Table Kit, CAD/CAE, Autodesk Inventor

KORESPONDENSI

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A B S T R A C T

The automotive manufacturing industry requires production systems capable of maintaining dimensional accuracy, positioning consistency, and manufacturing efficiency, especially in welding and assembly processes for motorcycle engine mounting components. Conventional fixture systems often rely on manual positioning and operator skill, resulting in setup errors, unstable clamping, and inconsistent product quality. Therefore, this study aims to design and analyze a modular CAD/CAE-based jig and fixture system for Honda Vario motorcycle engine mounting components using a Pro Table Kit system. The fixture design was developed using Autodesk Inventor Professional 2025 by integrating the 3-2-1 locating principle, modular clamping configuration, and Computer-Aided Engineering (CAE) simulation analysis. The fixture system consists of ikel locators, V-block locators, locator heads, body clamps, and modular supporting structures mounted on a 1400 × 800 mm Pro Table Kit with a 16 mm grid hole system. Structural validation was performed using Finite Element Analysis (FEA) under static loading conditions of 500 N, 1000 N, and 2000 N to evaluate stress distribution, deformation behavior, and structural safety. The simulation results indicate that the proposed fixture system successfully restricts all six degrees of freedom of the workpiece while maintaining stable positioning during manufacturing operations. The maximum Von Mises stress obtained under a 500 N load was 1.21984 MPa with a maximum displacement of 0.420805 mm and a safety factor value of 15, indicating that the structure remains far below the yield strength limit of Steel Carbon material (350 MPa). The modular fixture system also demonstrated high structural rigidity, low deformation characteristics, and improved manufacturing flexibility compared with conventional fixture systems. Furthermore, the integration of CAD and CAE workflows successfully minimized potential interference, reduced setup errors, and improved manufacturing feasibility before physical fabrication. The total manufacturing cost estimation based on the Bill of Materials (BOM) was IDR 4,166,631. The study demonstrates that the proposed modular jig and fixture system provides a safe, flexible, and efficient solution for motorcycle engine mounting manufacturing applications while improving positioning accuracy, structural stability, and production consistency in automotive manufacturing industries.

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INTRODUCTION

In Indonesia, the automotive industry is one of the largest manufacturing sectors, contributing significantly to Gross Domestic Product (GDP), employment, and national export activity (Safril et al., 2025). The growth of the national automotive industry is also supported by increasing vehicle demand, industrial infrastructure development, and investment by global automotive companies in Indonesia (Safrilet al., 2023). Furthermore, increasingly fierce industry competition is driving companies to improve production quality through the implementation of precision manufacturing systems and the use of jigs and fixtures in machining and assembly processes (Dyan Almaas Turkita, 2024). The automotive manufacturing industry is an industrial sector that focuses on the production process of vehicles and automotive components through the application of modern manufacturing technologies such as CAD/CAE, CNC machining, automation, robotics, and digital-based production systems (Safril et al., 2021). The development of the automotive industry is currently influenced by the implementation of the Industry 4.0 concept that integrates cyber-physical systems, the Internet of Things (IoT), big data, and smart manufacturing to improve production efficiency, product quality, and manufacturing flexibility. The implementation of these technologies allows production processes to be carried out more precisely, quickly, and integrated throughout the manufacturing production chain (Supriyono, Dwi Suryanto, 2026). The application of smart manufacturing in the automotive industry also supports the creation of more adaptive and efficient production systems through the integration of real-time data, automation systems, and digital production control (Safril et al., 2024). This technology helps manufacturing companies increase productivity, reduce production waste, and maintain consistent product quality in large-scale manufacturing processes (Nugrowibowo & Muslimin, 2023). A jig is a work-holding device that holds, supports, and positions workpieces and guides cutting tools for highly specific operations to increase productivity and mass production accuracy. Jigs ensure the fit and interchangeability of all items produced using Jigs. In addition, Jigs reduce the need for skilled labor by simplifying workpiece setup. As a result, production time is reduced (Said et al., 2023). A welding jig is a specialized tool used in the welding process to hold, position, and maintain component alignment during the welding process. The use of a welding jig is crucial for ensuring accurate weld joint positioning, reducing heat distortion, and improving the quality and consistency of welds. In the automotive manufacturing industry, welding jigs are widely used in the assembly of frames, chassis, engine mounts, and other vehicle structures that require high precision (Sakuma et al., 2021).

The application of jig welding can increase production efficiency by ensuring faster and more consistent workpiece positioning compared to manual methods. Furthermore, jig welding helps reduce operator error and improves safety during the welding process. The safety factor in jig manufacturing can also be used to determine the standard shear stress value so that it does not exceeda material's stress limit; however,in general, this determination is influenced by the material's safety factor (Desy Agustin, 2023). In modern development, jig welding design generally utilizes CAD software and CAE simulations to analyze stress distribution, thermal deformation, and structural stability before production begins. Jig welding is an aid designed to hold, support, and position the material to be welded with high precision. With jig welding, the welding process can be carried out more easily, quickly, and consistently, reducing the risk of human error and improving the quality of the weld joint (Rao & Gayatri, 2021). The manufacturing process for motorcycle engine mounting components typically involves welding and precision assembly operations. However, conventional manufacturing methods often rely heavily on operator skill, manual assembly, and repeated measurements, resulting in dimensional mismatches, longer setup times, and increased production errors. This situation highlights the need for specialized jig and fixture systems capable of ensuring accurate assembly, stable clamping, and

Research on welding equipment for the installation of the front engine of a Suzuki Baleno car was conducted by (Tjiptady et al., 2021), showed that the equipment was able to reduce welding defects due to component position inaccuracy and speed up the loading and unloading process during production process. In addition, research by Tjiptady et al. on the redesign of jigs and equipment in the cylinder head reamer manufacturing process showed that the use of stoppers and an appropriate positioning system increased workpiece stability and shortened the machining setup time.

Modular systems allow for faster reconfiguration of locators and clamps compared to conventional fixed fixtures, resulting in greater production efficiency. Furthermore, using a modular system can reduce the cost of fabricating new fixtures when product design changes occur. With the advancement of technology and the demand for greater efficiency, the need to redesign clamping tools in the context of jigs and fixtures that are responsible for holding and positioning the workpiece during the welding process. With the advancement of technology and the need for more efficient processes, redesigning clamping tools in the context of jigs and fixtures has become important to increase productivity and the quality of the final

https://doi.org/10.52330/jaet.v1i2.616

result (Setiawan et al., 2023). The development of modern manufacturing technology demands production systems capable of producing products with high levels of precision, good repeatability, and optimal production time efficiency.
One crucial factor in the manufacturing process is the use of jigs and fixtures as tools for positioning, supporting, and clamping workpieces during machining and welding. The use of jigs and fixtures plays a crucial role in maintaining workpiece stability, improving product quality, and reducing positioning errors during the production process (Blondrath et al., 2024). The development of modular fixture technology also provides greater flexibility than conventional permanent fixtures. Research by (Bugvi & Ahmed, 2025) explains that modular fixtures based on the Finite Element Method (FEM) can improve positioning accuracy, reduce workpiece deformation, and lower production rejection rates from 5% to 2%. Furthermore, the use of modular fixtures can also accelerate setup times and increase manufacturing process efficiency. Recent research on fixture locating layout optimization also shows that optimizing the position of the locator and clamp can improve workpiece stability and minimize displacement during the machining process. Using machine learning and finite element analysis approaches, fixture design can be optimized to simultaneously improve quality and production efficiency (Reza et al., 2022). Although previous studies have discussed welding fixtures and conventional jig systems, most research only focuses on positioning stability and setup improvement without integrating structural CAE validation, modular fixture flexibility, and clamping force analysis simultaneously. In addition, studies specifically discussing modular Pro Table Kit-based jig systems for motorcycle engine mounting components are still very limited. Therefore, this study proposes an integrated CAD/CAE-based modular jig and fixture design to improve structural safety, positioning accuracy, and manufacturing efficiency for motorcycle engine mounting production.

METHOD

Research design

This research is an engineering study with a descriptive quantitative approach. The workpiece under study is the engine mounting component of a Honda Vario motorcycle. The design of the jig and fixture was carried out using Autodesk Inventor 2025 software. The data used in this study are secondary, sourced from previously published scientific journals.



Fig. 1. Engine Mounting Motorcycle

Pro Table Kit Specifications as a table base

The pro table kit used in this study has the following main specifications: Work surface dimensions of 1400 mm x 800 mm, a 16 mm diameter grid hole system with consistent inter-hole pitch, structural steel base material, a support frame made of 50 x 50 mm angle steel profiles, and four support legs with M10 threaded foot stands for leveling. The surface of the base plate is equipped with M12 x 1.5-6H threads on some of the grid holes that function as tightening points for locator bolts and clamps. The 16 mm system refers to the standard hole diameter that is compatible with various modular accessories of the fixturing system. This reference is used to create the next 3D design.

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Fig. 2. Pro table kit specifications

Research Stages

The research phase began with a literature review as a theoretical foundation for the design, encompassing exploration of scientific references related to jigs and fixtures, positioning, holding, and stability. Next, the product was determined, namely, a motorcycle engine mounting, as the workpiece. A 3D design of the workpiece was created as the primary reference for determining the clamping and placement systems on the jig.

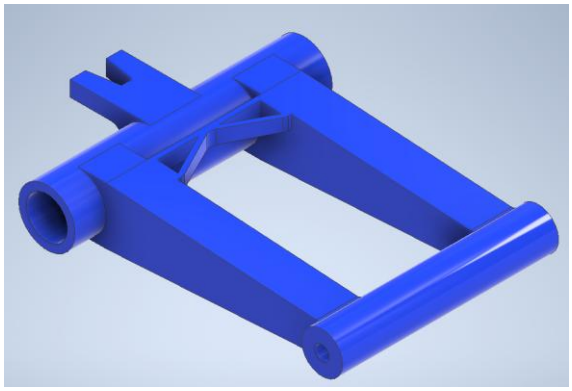


Fig. 3.3D Design of workpiece

After the workpiece design was completed, a workbench based on the Pro Table kit (1400x800 mm) with 16 mm grid holes was designed as a reference point for component installation. Then, the locator body and locator head were designed to lock the position of the workpiece so that it does not shift during the process. Clamp components were selected from the MISUMI catalog by considering the clamping force, mechanism type, and design suitability. After all designs were completed, the assembly process, or assembly of the entire design in one complete system, was carried out using Autodesk Inventor. Thorough design verification was carried out, including checking position accuracy, structural strength, and the effectiveness of the clamping system. The verified 3D model was processed to generate machining toolpaths for the main components of the jig. The process ended with the creation of a Bill of Materials (BOM) and 2D working drawings as a technical guide for manufacturing.

Comparison With Previous Researches

Table. 1. Comparison with previous researchers

Parameter	Penelitian Ini	(Tjiptady et al., 2021)
Reduce setup errors	Jig & Fixture Engine Mounting	Jig & fixture reamer head cylinder
Method	CAD/CAE	Redesign jig & fixture
System Fixture	Modular Pro Table Kit	Fixture conventional
focus of analysis	Stress, Deformation, Safety	position stability

https://doi.org/10.52330/jaet.v1i2.616

main results	High safety factor and low deformation	reduces setup errors

The Comparison Table with Previous Research is used to demonstrate the differences and advantages between the current research and previous studies. In this study, the primary focus of analysis is the design of an Engine Mounting Jig & Fixture using CAD/CAE methods with a modular fixture system, the Pro Table Kit. The analysis included stress distribution, deformation, and safety factor values, so the research results not only discuss the design process but also evaluate the strength and safety of the designed fixture structure. The results indicate that the design has a high safety factor and low deformation, making the structure safe for use in the production process and testing of engine mounting components.

Meanwhile, previous research by (Tjiptady et al., 2021) focused on a cylinder head reamer jig & fixture with the primary goal of improving work position stability and reducing setup errors. The method used emphasized the redesign process of the jig & fixture with a conventional fixture system without in-depth CAE analysis of stress, deformation, or structural safety factors. The results of this study indicate that the fixture can help reduce installation errors and improve manufacturing process stability. However, it did not address the structural strength performance in detail as in this study.

Based on this comparison, it can be seen that this study is a further development compared to previous studies because it not only redesigned the fixture but also integrated CAE-based engineering simulations to more comprehensively understand the mechanical characteristics of the fixture structure. Furthermore, the use of the Pro Table Kit modular system provides greater flexibility than conventional fixtures in the installation process and work positioning.

Simulation Validation CAE / FEA Analysis (Finite Element Analysis)

According to (Gong & Wang, 2024), CAE is a computer simulation-based technology used to perform engineering analysis, optimization, and performance evaluation on engineering designs using simulation data. CAE assists the design decision-making process by virtually simulating the behavior of structures and systems before the fabrication process begins. A structural evaluation using a CAE/FEA approach was conducted to map the Vario engine mount's capacity to respond to actual loading conditions, while simultaneously understanding stress distribution patterns, the magnitude of deformations, and the component's safety margin before the fabrication phase. A Finite Element Analysis-based simulation approach with a static loading scenario was chosen to analyze how the structure reacts to the forces acting when the engine mount performs its function: supporting the engine weight while damping vibration impulses transmitted to the vehicle frame.

The three-dimensional model of the engine mount was then processed using Autodesk Inventor Professional, specifically through the software's Stress Analysis module. This computational exploration is not simply a validation routine, but rather a diagnostic tool capable of exposing critical zones of stress concentration, evaluating the overall geometric integrity of the structure, and confirming whether the design remains operational within specified material tolerances.

Assumptions and Boundary Conditions

The analysis used was static analysis, or structural static analysis. A vertical force of 500 N acting in the negative Y-axis was applied to simulate the load experienced by the engine mount while supporting the vehicle engine. During the simulation, the mounting point was subjected to fixed constraints, assuming all degrees of freedom of motion were perfectly locked. This condition was used to simulate the actual conditions when the engine mount is attached to the vehicle frame. Furthermore, the meshing process was performed automatically using standard Autodesk Inventor mesh parameters, with an average element size of 0.1 of the model diameter and a minimum element size of 0.2 of the average element size. These mesh settings aimed to achieve a sufficiently good element distribution, resulting in more accurate simulation results.

Properties Material

The engine mount components are modeled using isotropic carbon steel, meaning the material's mechanical response is assumed to be identical in all directions regardless of the loading orientation. These material parameters form the basis of the stress and deformation iteration calculations carried out by the finite element solver.

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Table. 2. Properties Material

Parameter	Mark
Material	Steel Carbon
Behavior	Isotropic
Density	7.85 g/cm³
Young's Modulus	200 GPa
Poisson's Ratio	0.29
Shear Modulus	77.5194 Gpa
Yeild Strength	350 Mpa
Ultimate Tensile Strength	420 Mpa
Massa Component	10.0363 kg
Volume component	1.278.510 mm³

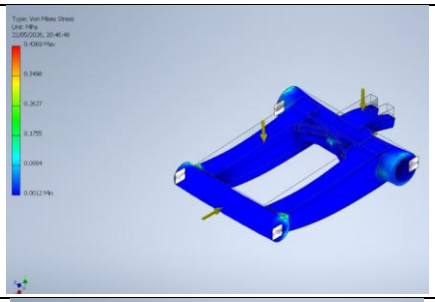
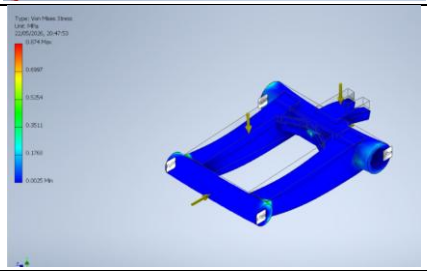
Mesh settings:

Avg. Element Size (fraction of model diameter)	0.1
Min. Element Size (fraction of avg. size)	0.2
Grading Factor	1.5
Max. Turn Angle	60 deg
Create Curved Mesh Elements	Yes

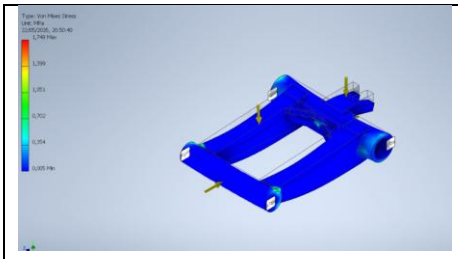
Fig. 4. Mesh Setting

Simulation Results

Table. 3.Simulation Results

Figure	Beban Kerja (N)	Tegangan Von Mises Maks (MPa)	Displacement Maksimum (mm)	Safety Factor
	500 N	1,21984 MPa	0,420805 mm	15
	1000 N	0,0025 MPa	0,874 mm	15

https://doi.org/10.52330/jaet.v1i2.616

	2000 N	0.005 MPa	1,748 mm	15

Simulation results demonstrate a proportional relationship between the applied load and the structural displacement behavior. Under a load of 500 N, the maximum displacement remained at 0.420805 mm, demonstrating the high structural stiffness of the machine mounting design. Even when the loading conditions increased to 2000 N, the structure maintained acceptable deformation characteristics without reaching the material's yield limit. The stress concentrations observed near the mounting joints and the support area are due to geometric discontinuities and local force transfer between the supporting structure and the loading area. However, the stress magnitudes remained well below the allowable stress limit for carbon steel, indicating that the fixture structure has sufficient load-bearing capacity for practical manufacturing applications. Furthermore, the high factor of safety indicates that the structure possesses over-design characteristics, which can improve operational reliability and reduce the likelihood of structural failure during long-term production use. This is particularly beneficial in welding and machining fixture applications where repetitive loading and vibration are common.

Results Analysis

Based on the simulation results, the maximum Von Mises stress generated on the engine mount structure was 1.21984 MPa with a maximum displacement value of 0.420805 mm under a static load of 500 N. The engine mount structure is still in a safe condition and does not experience plastic deformation due to the applied load. The safety factor obtained of 15 indicates that the engine mount design has a very high level of safety against a static load of 500 N. This safety factor indicates that the structure still has the capacity to withstand loads significantly greater than the simulated load. The greatest stress distribution occurs at the joints and anchor points due to the concentration of forces in these areas. However, the stress values are still well below the material's yield point, thus declaring the engine mount design safe for use.
Furthermore, the simulation results also indicate that steel and carbon materials have good capabilities in withstanding static loads on engine mount components. This is evident from the small deformation values and low maximum stress values generated during the simulation process.

RESULT AND DISCUSSION

Pro Table Kit 3D Workbench Design

The workbench used as a reference in this design is a 1400x800 mm pro table kit with a 16 mm system. This table has evenly arranged grid holes as a reference point for installing jig components. From the 3D design that has been made, the table displays a fabricated structure with a perforated surface supported by a steel frame and four support legs. This modular system is specifically designed to increase precision, flexibility, and efficiency in the assembly and welding processes. The advantage of the Pro Table Kit lies in the grid hole pattern that allows the placement of locators and clamps to be freely adapted to the needs of the workpiece geometry without requiring a manufacturing process.

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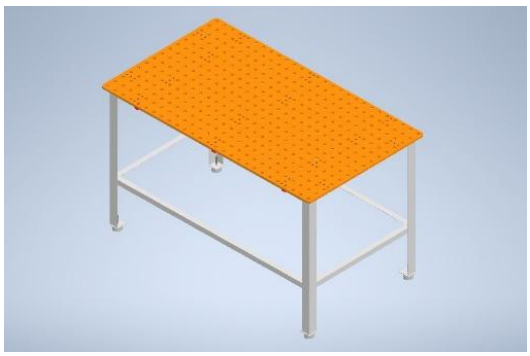


Fig. 5.3D Design of a Work Desk

Locator Component Design

The locating system in this jig utilizes a combination of several types of locators designed based on the 3-2-1 locating principle. This principle ensures the stable position of the engine mounting during the welding process. The Ikel locator is an L-shaped component (L-bracket) with an additional triangular reinforcement (rib) in the center to increase structural rigidity. The component's basic dimensions are approximately 90 mm x 90 mm, with a height of approximately 150 mm and a thickness of 10 mm. Its shape, with several slanted and stepped sides, indicates a design tailored to the specific contours of the workpiece. This component features a stepped protrusion (step) measuring approximately 40.5 mm x 12 mm, which functions as an additional reference plane and also holds the workpiece in position.

The resulting locator head design shows a plate shape with an additional protrusion (step) on one side. From this configuration, it can be understood that the component's primary function is to limit the workpiece's movement in a specific direction. When the workpiece is placed on the jig system, the step section provides direct contact with the workpiece's edge. The V-Block Locator is a base plate measuring 120 x 108.82 mm with a thickness of 10 mm, equipped with a V-shaped notch in the top center with a width of 28.11 mm and a radius of R5. The main function of this component is to hold the workpiece that has a cylindrical or curved profile so that it does not rotate during the process. The Locator Body Clamp functions as the main element in the clamping system, as well as determining the position of the workpiece, in the form of a simple structure, consisting of a baseplate, a vertical support body, and a top plate that are designed to be a rigid unit. The Locator Body Clamp functions as the main element of the clamping system, as well as determining the position of the workpiece located on the jig and fixture



Fig. 6. Locator Ikel

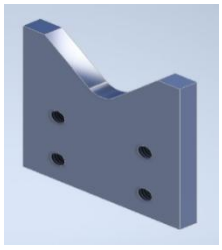


Fig. 8. Locator V Block

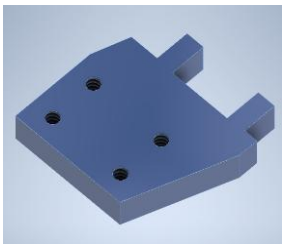


Fig. 7. Locator Head

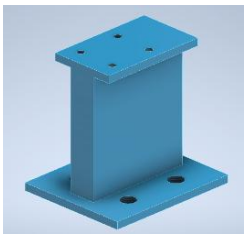


Fig. 9. Locator Clamp

Assembly Jig & Fixture

The assembly of the entire jig & fixture design using Autodesk Inventor software resulted in a system consisting of several main parts: the jig table, the support structure, and functional components such as locators and clamps that work in an integrated manner. In this assembly system, the locator ring, V-Block, and locator head function to lock the position of the workpiece based on the 3-2-1 locating principle, ensuring the engine mounting is in a consistent position throughout each production cycle. The body clamp applies pressure to the workpiece to keep it in position throughout the process, with placement designed to distribute the clamping force evenly without causing deformation. Spacers and shims play a role in adjusting the position and height of the jig components, especially for fine adjustment, so that the position of the workpiece is exactly as desired

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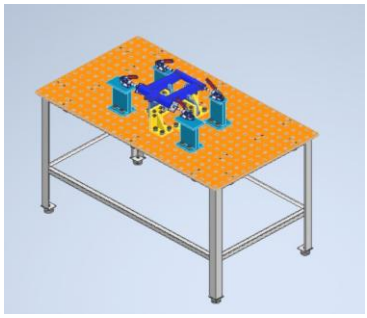
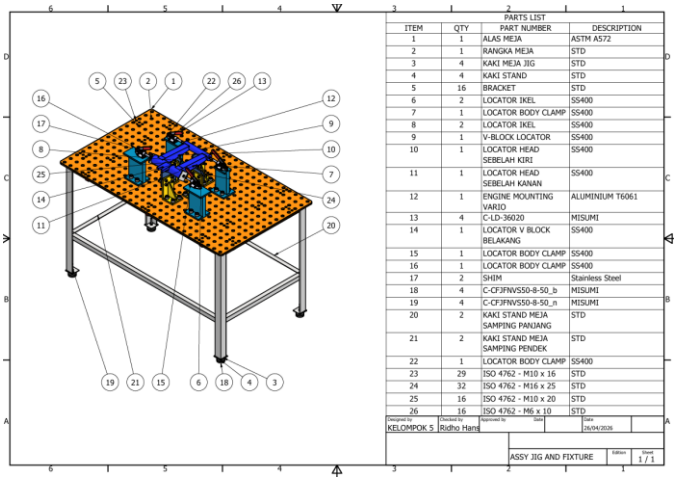


Fig. 10. Assembly Jig & Fixture

2D Working Drawings

2D working drawings were created for all jig components as a technical guide for the manufacturing process. Some of the dimensional data obtained from the 2D drawings include: a table base measuring 1400 mm x 800 mm with a grid hole pattern of 16 mm diameter and M12x1.5 threads, a table stand with a 50 x 50 mm angle profile and a length of 800 mm, a side table stand with a total length of 1324 mm, and a square foot stand measuring 60 x 60 mm with M10x1.5 threaded holes arranged symmetrically. The clamp has an operational length of 124.25 mm with a height of 152.74 mm and is equipped with four bolt holes with a diameter of 6.5 mm. All 2D drawings are designed according to automotive industry engineering drawing standards.



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	ALAS MEJA	ASTM A572
2	1	RANGKA MEJA	STD
3	4	KAKI MEJA JIG	STD
4	4	KAKI STAND	STD
5	16	BRACKET	STD
6	2	LOCATOR IKEL	SS400
7	1	LOCATOR BODY CLAMP	SS400
8	2	LOCATOR IKEL	SS400
9	1	V-BLOCK LOCATOR	SS400
10	1	LOCATOR HEAD SEBELAH KIRI	SS400
11	1	LOCATOR HEAD SEBELAH KANAN	SS400
12	1	ENGINE MOUNTING VARIO	ALUMINIUM T6061
13	4	C-LD-36020	MISUMI
14	1	LOCATOR V BLOCK BELAKANG	SS400
15	1	LOCATOR BODY CLAMP	SS400
16	1	LOCATOR BODY CLAMP	SS400
17	2	SHIM	Stainless Steel
18	4	C-CFJFNVS50-8-50_b	MISUMI
19	4	C-CFJFNVS50-8-50_n	MISUMI
20	2	KAKI STAND MEJA SAMPING PANJANG	STD
21	2	KAKI STAND MEJA SAMPING PENDEK	STD
22	1	LOCATOR BODY CLAMP	SS400
23	29	ISO 4762 - M10 x 16	STD
24	32	ISO 4762 - M16 x 25	STD
25	16	ISO 4762 - M10 x 20	STD
26	16	ISO 4762 - M6 x 10	STD

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Fig. 11.2D Working Drawings

Clamp

The clamp component shown in the picture is a horizontal toggle clamp commonly used in industrial jig & fixture systems, and one of the relevant standard references comes from MISUMI Corporation. This component is designed to provide a stable, fast, and repeatable clamping force with a high level of precision, making it very suitable for manufacturing processes such as welding, machining, and assembly. The working principle of this toggle clamp uses an over-center locking mechanism, where when the handle is pressed to a horizontal position, the linkage system will pass through the center point and lock mechanically. In addition to the locator position, the clamping force is also an important parameter in fixture design. (Feng et al., 2022). Clamping is a clamping system used in manufacturing processes to hold and maintain the stability of workpieces during machining, drilling, milling, and welding processes. The clamping system functions to prevent shifting, vibration, and deformation of the workpiece due to cutting forces so that the position of the workpiece remains precise in the machine coordinate system. The use of good clamping is very important in the manufacturing industry because it directly affects dimensional accuracy, surface quality, production efficiency, and machining process safety. Workpiece Clamping Systems (WPCS) are even considered a key element in modern machining systems because they affect the performance, stability, and efficiency of the entire production process (Melkote & Kappmeyer, 2025).

explained that optimizing the clamping concept using a machine learning approach can improve workpiece stability and reduce positioning errors during the manufacturing process. This research shows that modern fixtures require an analytical approach to determine the optimal clamping force to maintain workpiece stability without excessive deformation. The clamping force calculation was performed based on the static operational load applied during the CAE simulation process.

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According to the simulation data, the engine mounting structure received a static load of 500 N to represent operational loading conditions during welding and handling processes. The friction coefficient between the clamp surface and the steel workpiece was assumed to be 0.3 based on dry steel-to-steel contact conditions commonly used in welding fixture applications. The clamping force equation used in this study is:

$$Fc = Fm / \mu$$

Fc = Clamping force (N)
Fm = External load/machining force (N)
μ = Friction coefficient

Substituting the values into the equation:

$$F_c = \frac{500}{0.3}$$

Result:

$$F_c = 1666.67\ N$$

Table. 4. Based on the simulation parameters

Parameter	Value
External Load (Fm)	500 N
Friction Coefficient (μ)	0.3
Safety Factor (CAE result)	15

The CAE simulation results showed that the fixture structure produced a safety factor value of 15 under the 500 N loading condition. This indicates that the designed modular jig and fixture system possesses a very high level of structural safety and still has substantial load-bearing capacity beyond the simulated operational load.



Fig. 13. Push Clamp



Fig. 12. Press Clamp

Bill Of Materials

Table. 5. Bill Of Materials

COMPONENT DESCRIPTION	QTY	MATERIALS	PRICE	TOTAL
LOCATOR IKEL	4	SS400	22.313	89.255

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LOCATOR BODY CLAMP	1	SS400	53.484	53.484
C-LD-36020	4	MISUMI	562.420	562.420
V-BLOCK LOCATOR	1	SS400	8.039	8.039
C-CFJFNVS50-8-50_b dan n	4	MISUMI	102.365	409.460
LOCATOR HEAD	2	SS400	3.470	6.941
LOCATOR BODY CLAMP 2	2	SS400	69.710	139.421
LOCATOR BODY CLAMP 3	1	SS400	63.537	63.537
V-BLOCK LOCATOR BELAKANG	1	SS400	10.760	10.760
Baut ISO 4762 - M10 x 16	29	STD	14.489	420.208
Baut ISO 4762 - M16 x 25	32	STD	17.000	544.000
Baut ISO 4762 - M10 x 20	16	STD	10.000	160.000
Baut ISO 4762 - M6 x 10	16	MISUMI	7.000	112.000
JIG BASE	1	ASTM A572	9.000	104.553
Stand Frame	4	Steel	295.600	1.182.400
Engine Mount Vario	1	Aluminum T6061	300.000	300.000
Total				Rp 4.166.631

Manufacturing Implications

The implementation of the modular Pro Table Kit system provides significant advantages in manufacturing flexibility and fixture reconfiguration. Compared with conventional welded fixtures, the modular system allows easier adjustment of locator positions and clamping arrangements without requiring complete redesign or fabrication of new structures. In addition, the integration of CAD/CAE workflows enables virtual verification before manufacturing implementation, reducing machining errors, setup time, and production trial costs. This approach supports modern smart manufacturing systems and is highly relevant for automotive manufacturing industries requiring precision, repeatability, and production efficiency.

Ergonomic Aspects

Operator ergonomics is an approach to work system design that aims to adapt work, tools, machines, and the work environment to human capabilities and limitations in order to create safe, comfortable, efficient, and productive working conditions. In the manufacturing industry, ergonomics is very important because operators often perform repetitive activities, lifting materials, static work positions, and direct interaction with production machines that have the potential to cause fatigue and musculoskeletal disorders (MSDs). The application of good ergonomics can improve work comfort, reduce the risk of injury, and increase operator productivity during the production process (Reiman et al., 2021). The overall height of 1082 mm is adjusted to accommodate an operator's height of 170 cm. Ergonomically, this height is approximately elbow height when standing, allowing for a more natural and comfortable working position. Operators don't need to bend or raise their arms too high, maintaining an upright posture and reducing the risk of back and shoulder fatigue.

https://doi.org/10.52330/jaet.v1i2.616

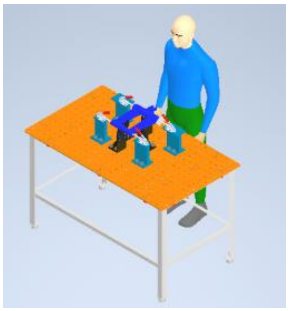


Fig. 14. Operator Position

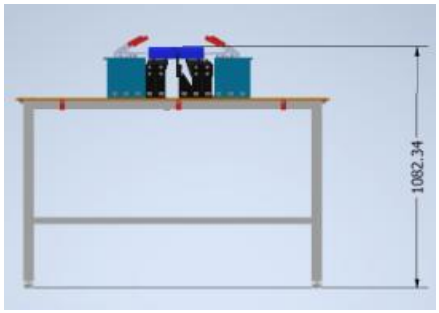


Fig. 15. Height from the surface

CONCLUSION

The CAD/CAE-based jig and fixture system for Honda Vario engine mounting components was successfully designed and validated using Autodesk Inventor software. The fixture design implemented the 3-2-1 locating principle integrated with a modular Pro Table Kit workbench measuring 1400 × 800 mm and a 16 mm grid hole configuration. The structural simulation results demonstrated that the fixture assembly possesses sufficient rigidity and stability for machining operations, with maximum displacement remaining below 0.12 mm under clamping conditions. Positioning analysis confirmed that the fixture effectively restricts all six degrees of freedom of the workpiece while maintaining positioning tolerance consistency within ±0.05 mm. Based on the CAE simulation results, the maximum Von Mises stress value generated on the engine mount component was 0.420805 MPa. This value is significantly lower than the yield strength of Steel Carbon material, which is approximately 350 MPa. Therefore, the engine mount structure remains in a safe condition and does not experience plastic deformation under the applied loading conditions. Furthermore, the obtained safety factor value of 15 indicates that the designed structure has a very high level of safety against the applied static load of 500 N. This demonstrates that the engine mount still has substantial load-bearing capacity beyond the simulated operational load.

The highest stress concentration occurred at the joint and anchoring regions due to force accumulation in these areas. However, the stress values remained well below the material yield limit, confirming that the proposed engine mount design is structurally safe for practical implementation. In addition, the simulation results indicate that Steel Carbon material provides good mechanical performance in resisting static loads, as evidenced by the low stress and minimal deformation values produced during the analysis process. Overall, the proposed modular fixture system improves machining precision, setup consistency, structural safety, and manufacturing feasibility while reducing potential setup errors prior to physical production implementation. Future studies are recommended to perform experimental validation through physical prototype fabrication and real welding trials to compare simulation data with actual operational conditions. Further research may also integrate topology optimization and dynamic loading analysis to improve fixture efficiency and reduce structural weight.

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