

Design of Drill Jig and Milling Fixture for the Component Button Lock

Mahendra H S, Hemaraju, Siddartha D.E

Abstract— In the present study a milling fixture and drill jig was designed, developed for the component bracket for seat arrangement. As per the requirements of rigid and economic tool, the materials are selected for both Jig and Fixture. Standards of IS and BIS requirements for entire tool was followed in order to fulfill tooling requirements. A detailed modelling and detailing were done by CATIA v.15 modelling software. A complete procedure of fabrication was discussed and enumerated. Detailed costing and estimation were done and tabulated. Considering the perception and evaluation of tool design engineer it is concluded that the designed drill jig and milling fixture has good strength from design point of view and able to fulfill the requirements of tool and engineering department.

Keywords— Drill jig, Milling fixture, clamp plate.

I. INTRODUCTION

Jigs and fixtures are designed to hold, support and locate the work pieces to ensure that each part is machined within the specified limit. Use of jigs and fixtures provides a faster and more profitable method of manufacturing in which components can be quickly positioned in the correct relationship to the cutting tool. It is a device which locates and holds the component for a specific operation. It does not guide the cutting tool. It is a work holding device that holds supports and locates the work piece for a specific operation but does not guide the cutting tool. It provides only a reference surface or a device. What makes a fixture unique is that each one is built to fit a particular part or shape. The main purpose of a fixture is to locate and, in some cases, hold a work piece during either a machining operation or some other industrial process. A jig differs from a fixture in that as it guides the tool to its correct position in addition to locating and supporting the work piece. It is a device which is used to hold and position the work piece. In addition, it provides some means for guiding the cutting tool. A Jigs primary purpose is to provide repeatability, accuracy, and inter-changeability in the manufacturing of products. A jig is often confused with a fixture; a fixture holds the work in a fixed location. A device that does both functions (holding the work and guiding a tool) is called a jig. The word “tooling” refers to the hardware necessary to produce a particular product. A considerable amount of tooling is the result of work performed by the tool designer. Tooling, as viewed by the tool designer, consists of a vast array of cutting device, jigs, fixtures, dies, gages, etc., used in normal production. The type of production will determine to a large extent the type of tooling.

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The most common classification of types of tooling is as follows:

- Cutting tools, such as drills, reamers, milling cutters, broaches and taps.
- Jigs and Fixtures for guiding the tool and holding the work piece.
- Gauges and measuring instruments.
- Sheet-metal press working dies for all types of sheet-metal fabrication.
- Dies for plastic moulding, die casting, permanent moulding, and investment casting. Forging dies for hot and cold forging, upsetting, extrusion and cold finishing.

Charles Chikwendu Okpala & Ezeanyim Okechukwu C. tried identified the numerous advantages that are associated with the use of jigs and fixtures in manufacturing to include: production increase, cost reduction, inter-changeability and high accuracy of parts, reduction of the need for inspection and quality control expenses, reduction of accident as safety is improved, automation of machine tool to an appreciable extent, easy machining of complex and heavy components, as well as low variability in dimension which leads to consistent quality of manufactured products. **Shivaji Mengawade et al**, conduct a review on design and analysis of work Holding Fixture” and tried to attempt the study the efforts of marking, measuring and setting of work piece on a machine and maintains the accuracy of performance. The work piece and tool are relatively located at their exact positions before the operation automatically within negligible time. So, it reduces product cycle time. **Shailesh S.Pachbhai, Laukik P.Raut**, conduct a review on design of fixtures and tried to identify the reliability of the fixture design which results the fixture design has made more reasonable. To reduce cycle time required for loading and unloading of part, this approach is useful. If modern CAE, CAD are used in designing the systems then significant improvement can be assured. **Sangale Prabhakar S et al**, found out the method has to design and manufacture the Multipurpose Jigs and Fixture, for that component which has been to reduce the manufacturing cycle time. When the component manufactured on a small size previously this is to manufacture the large quantities of requirements. **Rushikesh D et al** attempted to study a very important part of generator canopy using the tool design. The jigs and fixtures assure that there will be accurate assemblage of part so the main components of generator like engine, alternator will be mounted properly on base frame. As we know the jigs and fixtures are economical ways to getting mass production. **Krsulja et al** prepared a model of modular fixture setup relative to cutting forces is proposed, need and assembled. Positioning is discussed and the best solution is offered. Tool movements influence the final quality of workpiece, and fixture influences tool movements.



II. DESIGN OF DRILL JIG

In the present study, A drill jig is designed which suits to the effective production of the component i.e. seat bracket for seating arrangement. A detailed procedure of drill jig design by considering all the requirements of tool engineering has been carried out throughout the study. There are many types of drill jigs which are already available in market have to be considered before going to the design of complete drill jig. The factors like time, cost economy, production life cycle, operator skill, availability of the machines, quality is to be considered before designing of the drill jig. All standards which are substantially standardized by international standard organization (ISO) long with tool engineering standards had referred before completion of drill jig design. Effective degree of freedom considering all 6 DOF was considered before design.

The following steps were followed for designing the drill jig for the given component:

- The drill jig designed using accurately manufactured and using interchangeable parts.
- The drill jig designed was able to produce large number of components within the production lead time.
- The drill jig was designed for the given component was economical and cost effective.
- The drill jig designed does not require a lot of skill and easy to operate.
- The designed was able to hold or grip a workpiece in the pre-determined manner and location.
- The drill jig designed was able to hold the relationship and alignment between the tool and workpiece.
- The drill jig designed was able to fulfil all the requirements of tool engineer.
- The materials used for drill jig design was able to withstand all cutting forces and wear while operation.
- The drill jig designed as made with the requirements for clean and free from swarf and grit.
- The drill jig designed is fulfilling all precision requirements.

2.1 MATERIAL SELECTION

The following materials were selected for the designed drill jig:

- **Bottom plate:** Hot rolled steel flat which confirmed the standards of IS: 1731-1971 was selected with the standard designation of C30 heat treatable.
- **Top plate:** Hot rolled steel flat which confirmed the standards of IS: 2073-1970 was selected with the standard designation of 40 Mn 2S 12 heat treatable.
- **Side plates:** Hot rolled steel flat which confirmed the standards of IS: 2073-1970 was selected with the standard designation of C20.
- **Clamping plate bolt:** Hot rolled steel flat which confirmed the standards of IS: 2073-1970 was selected with the standard designation of C20.
- **Latch clamp:** Hot rolled steel flat which confirmed the standards of IS: 2 909-1964 was selected with the standard designation of BM35.
- **Wedge:** Hot rolled steel flat which confirmed the standards of IS: 2073-1970 was selected with the standard designation of C14.
- **Socket head cap screws:** Selected from the standard available cap screws followed with the standard of IS: 4218-1971.

- **Drill bush:** A renewable drill bush followed with the material T105Cr1Mn60 and a standard of IS: 606-1972(Part 2).
- **Rest buttons:** Selected from the standard available cap screws followed with the standard of IS: 5095.

2.2 FABRICATION

Detailing of fabrication of the parts used in the drill jig are discussed below:

- **Bottom plate:** A steel flat followed with the standard 150mm×10mm (IS: 1730-1961) was taken and rough milling was done on both the sides of the bottom plate. A surface grinding on both the surface was done for double triangle surface finish. A hole of diameter of diameter 20mm was done by drilling machine for the purpose of easy removal of swarf's and chips. A hole of diameter 10mm is cut by drilling method to fix the wedge on to the top of the bottom plate by placing the head screws. A counter-boring was done for a diameter of 12mm and a height of for the proper seating of heads of the cap screws. Pocket milling was done for size 120mm×15mm×30mm on the top of bottom plate to fix the component on the drill jig. A heat treatment process of hardening and tempering was done by quenching the plate in water or oil or molten salt bath.
- **Top plate:** A steel flat followed with the standard 160mm×8mm (IS: 2073-1970) was taken and rough milling was done on both the sides of the bottom plate. A surface grinding on both the surface was done for double triangle surface finish. A U-groove of 52mm was cut by slot milling operation for the purpose of latch clamping. A hole for a diameter of M4 was drilled throughout the width of the plate by conventional milling machine.
- A hole at the exact Centre of the plate was drilled for a diameter of 18mm by CNC drilling machine with a tolerance limits of tool rigid for the purpose of press fitting the drill bush. A surface hardening by carburization process was done for one side of the plate and an induction hardening was done for the Centre hole.
- A heat treatment process of hardening and tempering was done by quenching the plate in water or oil or molten salt bath.
- **Side plate:** A steel flat followed with the standard 160mm×8mm (IS: 2073-1970) was taken and rough milling was done on both the sides of the bottom plate. A surface grinding on both the surface was done for double triangle surface finish.
- Conventional milling was done on one side of the plate to fix the top plate using clamping plate bolt. A hole of diameter 8mm is drilled on one side of the plate to fix the M jaw for the purpose of holding the component firmly. A hole of diameter 10mm is cut by conventional milling method on one side of the plate to hold the component in sideways. A U-groove is cut by conventional method and a diameter of 8mm is drilled on the U-groove to fix the clamping plate bolt.
- **Wedge:** A block for a size of 50mm×30mm is taken and is cut by means of conventional milling to the required size and grinding should be done on the back side of the wedge to give good surface finish and to hold the component firmly by avoiding the damage on the surface of the component. A hole of

diameter 8mm is cut by drilling method on the bottom of the wedge to fix the wedge to the drill jig by means of head screws. A heat treatment process of hardening and tempering was done by quenching the plate in water or oil or molten salt bath.

- Clamping plate bolt: The clamping bolt is selected with the standard of IS: 6336-1989 of size M8.
- Latch clamp: A latch clamp is selected by following the IS standard of IS: 2804
- Of size M16.
- Rest buttons: The rest buttons are selected by following the IS standard of IS: 5905 of size 10mm.
- Drill bush: The drill bush was selected by following the IS standard of IS: 666-1972 (part II) of size M29.

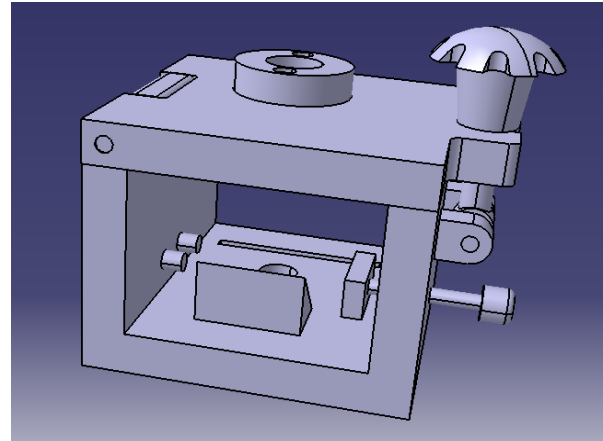


Figure.2.1: Assembled view of Drill Jig.

The detailed view of Drill jig was developed with front sectional view, top view and side view is shown in figure.2.2

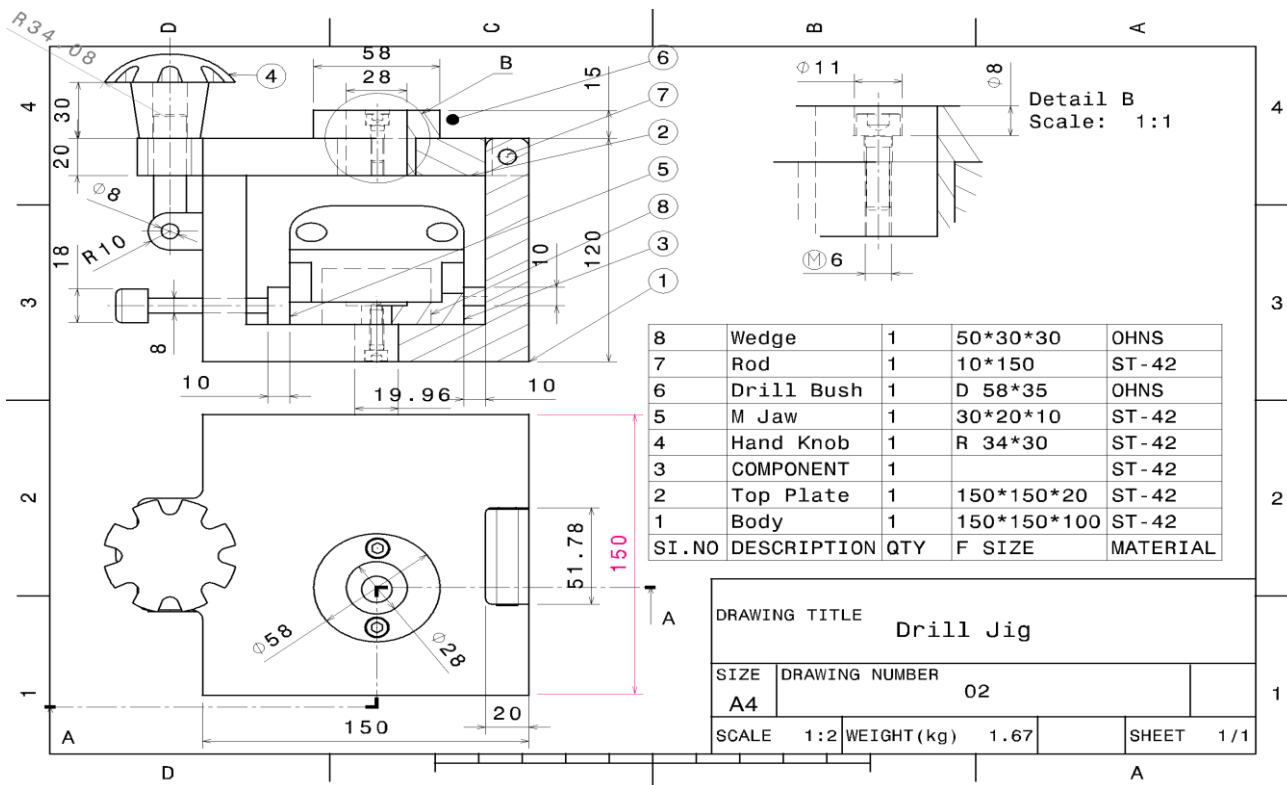


Figure.2.2: Detailed view of Drill Jig.

III. DESIGN OF MILLING FIXTURE

In the present study, A milling fixture is designed which suits to the effective production of the component i.e. seat bracket for seating arrangement. A detailed procedure of milling fixture design by considering all the requirements of tool engineering has been carried out throughout the study. There are many types of milling fixtures which are already available in market have to be considered before going to the design of complete milling fixture. The factors like time, cost economy, production life cycle, operator skill, availability of the machines, quality is to be considered

before designing of the milling fixture. All standards which are substantially standardized by international standard organization (ISO) long with tool engineering standards had referred before completion of milling fixture design. Effective degree of freedom considering all 6 DOF was considered before design.

The following steps were followed for designing the milling fixture for the given component:

- The milling fixture designed using accurately manufactured and using interchangeable parts.
- The milling fixture designed was able to



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produce large number of components within the production lead time.

- The milling fixture was designed for the given component was economical and cost effective.
- The milling fixture designed does not require a lot of skill and easy to operate.
- The designed was able to hold or grip a workpiece in the pre-determined manner and location.
- The milling fixture designed was able to hold the relationship and alignment between the tool and workpiece.
- The milling fixture designed was able to fulfil all the requirements of tool engineer.
- The materials used for milling fixture design was able to withstand all cutting forces and wear while operation.
- The milling fixture designed as made with the requirements for clean and free from swarf and grit.
- The milling fixture designed is fulfilling all precision requirements.

The base of milling fixture consists of a base plate which has flat and accurate under surface and forms the main body on which various components are mounted. This surface mates with the surface of the milling machine table and forms the reference plane with respect to the mill feed movements. The base is provided with slots for the purpose of clamping the fixture to the mill table. The clamping devices used should be extremely rigid, clamps must not loosen by vibrations caused by interrupting cutting of milling cutter. Rest blocks provide support to the work piece. Milling fixture should be of heavy, rigid construction to withstand the high milling cutting forces. A cast iron casting is chosen for the fixture body for this reason and also because it has the property of damping the vibrations during milling operation.

3.1 MATERIAL SELECTION

The following materials were selected for the designed drill jig:

- **Base plate:** Hot rolled steel flat which confirmed the standards IS: 1731-1971 was selected with the standard designation of C30 heat treatable.
- **Wedge:** Hot rolled steel flat which confirmed the standards IS: 2073-1970 was selected with the standard designation of C14.
- **Moving jaw:** Hot rolled steel flat which confirmed the standards IS: 1977-1969 was selected with the standard designation of St 42-S.
- **Stopper:** Hot rolled steel flat which confirmed the standards IS: 2073-1970 was selected with the standard designation of 40 Mn 2S 12 heat treatable.
- **Square block:** Hot rolled steel flat which confirmed the standards IS: 2073-1970 was selected with the standard designation of C14.
- **Support block:** Oil hardened non-shrinking steel (OHNS) is taken with the standard designation of CNE36.

3.2 FABRICATION

- **Base plate:** A steel flat followed with the standard 300mm×10mm (IS: 1730-1961) was taken and rough milling was done on both the sides of the bottom plate. A surface grinding on both the surface was done for double triangle surface finish.

A hole of diameter 10mm is cut by drilling method and threading should be done on the inside of the hole to fix

the wedge on to the top of the bottom plate by placing the head screws. A counter-boring was done for a diameter of 12mm and a height of for the proper seating of heads of the cap screws. A hole of diameter 8.5mm is cut by drilling method and threading should be done on the inside of the hole to fix the wedge on to the top of the bottom plate by placing the head screws. A counter-boring was done for a diameter of 15mm and a height of for the proper seating of heads of the cap screws. A U-groove of 30mm was cut by conventional slot milling operation for the purpose of fitting the T-bolts. Pocket milling was done for size 120mm×15mm×30mm on the top of bottom plate to fix the component on the drill jig.

A heat treatment process of hardening and tempering was done by quenching the plate in water or oil or molten salt bath. This design was done and is shown in the appendix

- **Wedge:** A block for a size of 50mm×30mm is taken and is cut by means of conventional milling to the required size and grinding should be done on the back side of the wedge to give good surface finish and to hold the component firmly by avoiding the damage on the surface of the component. A hole of diameter 8mm is cut by drilling method on the bottom of the wedge to fix the wedge to the drill jig by means of head screws. A heat treatment process of hardening and tempering was done by quenching the plate in water or oil or molten salt bath.
- **Moving Jaw:** A steel tube followed with the standard 15mm (IS: 1977-1969) was taken and turning operation is carried out for diameter 5mm along certain length. A surface grinding was done on full length of the body. Threading should be done on the small diameter rod to move the moving jaw fixed to the stopper in horizontal direction to fix the component firmly in the milling fixture.
- **Stopper:** A block for a size of 75mm×30mm×25mm is taken and is cut by means of conventional milling to the required size and grinding should be done on one side of the block where the component is touching to hold the component firmly. A hole of diameter is cut by drilling to fix the moving jaw to this stopper. A heat treatment process of hardening and tempering was done by quenching the plate in water or oil or molten salt bath.
- **Square block:** A block for a size of 35mm×25mm is taken and is cut by means of conventional milling to the required size and grinding should be done on full square block. A hole of diameter is cut to the certain length by drilling on the bottom side of the block and threading should be done to that hole to fix the block on milling fixture by means of head screws. A hole of diameter is cut horizontally throughout the block and threading should be done to that hole to move the moving jaw.

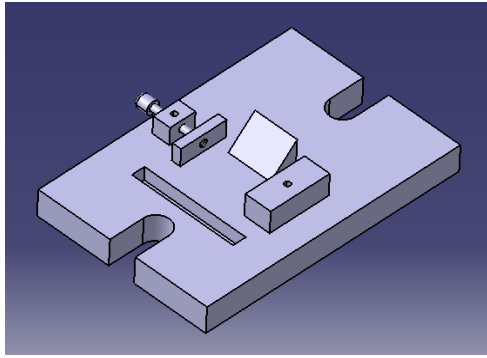


Figure 3.1: Assembled view of Milling Fixture.

The detailed view of milling fixture was developed with front sectional view, top view and side view is shown in figure: 3.2.

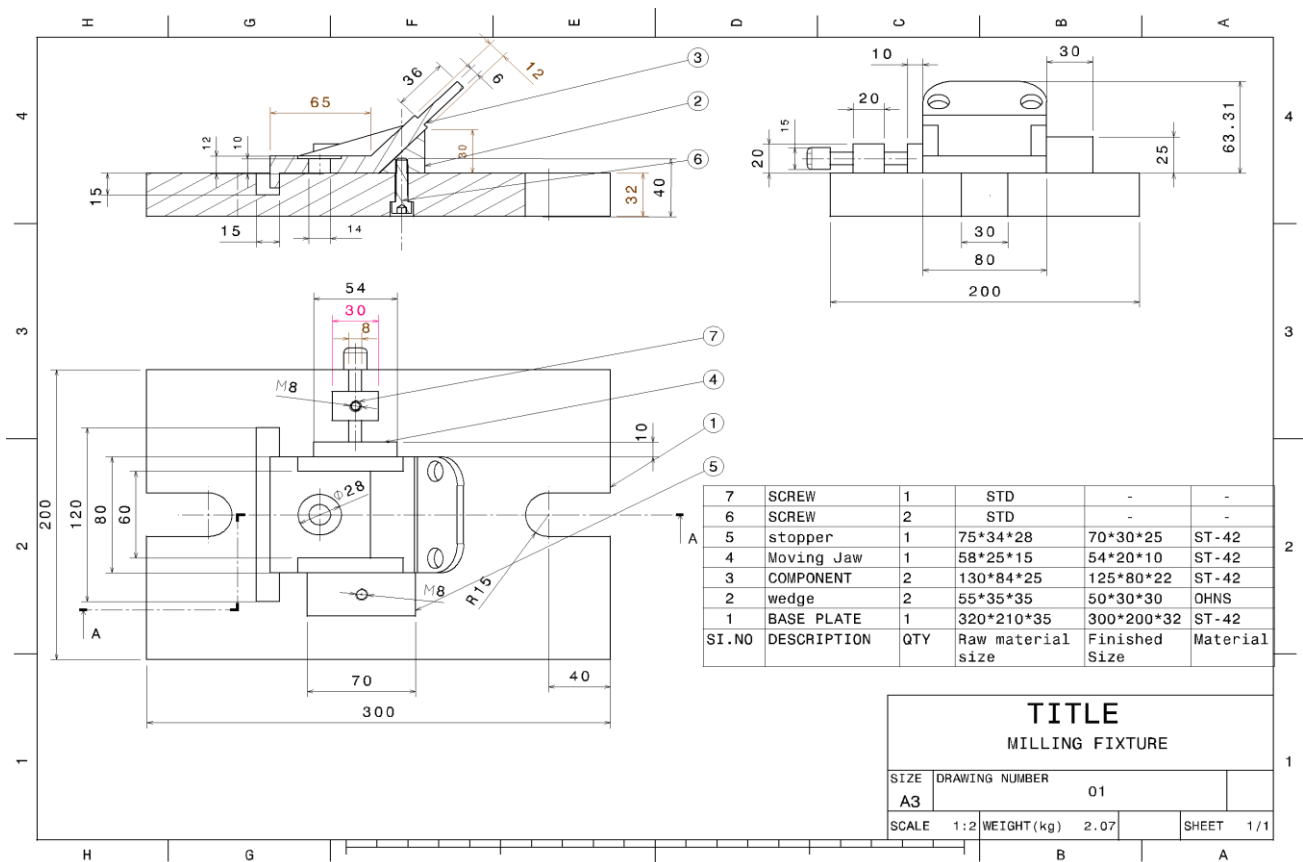


Figure 3.2: Detailed view of Milling Fixture.

IV. CONCLUSIONS

By complete design, drafting and costing of drill jig and milling fixture, the following conclusions were made from the study point of view.

DRILL JIG

- Designed Drill jig will be economical from the production point of view.
- All standards of IS, GTTC and BIS were followed throughout the study, hence easy to manufacture.
- Designed Drill jig had good strength from design point of view.

- Designed jig will be able to produce more than 10000 components.
- Designed Drill jig will fulfill the requirements of tool and engineering department.

MILLING FIXTURE

- Designed milling fixture is economical and flexible from the production and design point of view.

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- Designed milling fixture having high strength from design point of view.
- Designed milling fixture has less wear capacity and locking force between the component and the jaw is very minimal and hence the damaging of the component is reduced.

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