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SMED Concept In Forging Die Setup

Shah Jaimin H.[1], Patel Umang A.[2], Patel Sumit K.[3]

[1]Mechanical Engineering Department, Vadodara Institute of Engineering
[2]Mechanical Engineering Department, Vadodara Institute of Engineering
[3]Mechanical Engineering Department, Vadodara Institute of Engineering

Abstract —*The determination of the Single Minute Exchange Die (SMED) is to remove the waste of time. Longer set-up time indicates that the production line is not productive as their competitor and will lose by their competitor. Today, everything is been done faster and just-in-time, so, the main aim of the manufacturer is that to produce a part as fast as possible with maintaining its' quality and then deliver it to the customer right on time. There are so many production units where we require SMED system i.e. in plastic molding, in forging, in injection molding, in punching press and so on. In forging industry, the die setup is extremely irritating and time-consuming. During that time a press remains idle. So, no production is taking place. During die changing it is required for internal & external set up of die. So, during internal setupoperations, the press is kept idle. Therefore it has been tried to reduce the internal setup time*. The main aim of this literature review is to study about "How SMED system is helpful for die setup of forging hammer?"

Keywords- *SMED, die setup, forging hammer, internal setup, just-in-time*

1 INTRODUCTION

1.1 Forging Concept

Forging is one kind of metal forming process in which metal can be shaped into required shape by applying continuous compressive forces by means of a hammer or forging press.In the forging process the metal can be deformed by means of following three manners:

- By applying continuous compressive force if the length of the billetis increased and diameter of the billetare decrease then it is known as drown.
- By applying continuous compressive force if the length of the billet is decrease and diameter of the billetare increase then it is known as upset.
- By applying continuous compressive force by means of closed die forging hammer then a billet can be shaped according to the shape of the die which is known as squeezed.

Die is a forging tool by means of which we can shape our metal as per our requirement. Initially, our metal is in the form of billet or ingot or rod, then we perform a number of deformation processes to achieve the desired shape. The main aim of any industry is to increase productivity and accuracy, for increasing productivity in forging industry skilled workers are required but with the help of impression tools which are also known as a die, we can achieve an accuracy in forging products.

The parts which are produced by forging method are generally used in an area where trustworthiness and human safety are crucial. Actually, forging is helpful in safety-related applications. The most common application areas are automotive, aerospace, national defense, construction, mining, pipeline, valves and fittings, material handling and general industrial equipment.

1.2 Forging Dies

In hot forging operation according to die they are classified as open die forging and closed die forging. In open die forging a flat die is used. In open die forging it is difficult to handle the metal. In open die forging when we apply continuously compressive forces. Then metal can be deformed in any shape. For maintaining the shape of the metal skilled labor are required who can continuously handle the metal during forging operation and give the final shape of the workpiece. In closed die forging die which has an impression of the product that we want at the end of the forging process. In closed die forging there is a set of the die which has upper die and lower die. Both dies has an impression of the final product. The metal is placed between the upper die and lower die then by applying continuously compressive forces by means of forging hammer then a metal can be deformed as per the shape of the die. In closed die forging there is a less chance of wastage of metal. But the setup of the closed die in forging hammer is a time-consuming process.

Die life depends on the diversity of causes like workpiece and billet material, suitable workpiece design, die material hardness, driving equipment type and forging temperature.

1.3 Current Die Changing Methods

As we know that the final products which are produced by the forging process require multi-operation so, it is a multi-operational process. According to the geometry of the part, forging die pressure, billet's temperature a forging dies are designed. The most important which is used in the mounting of forging die is 'cassette'. This is the element in which dies are inserted and die set is generated. The die sets (both upper and lower) are fixed to the die holders. The upper die holder is fixed to the ram of the forging press and lower die holder is fixed to the anvil bolster of the press.

Die setup process is too many time-consumingprocesses. This process starts with removing the previous die set to the final inspection of the first part which is produced. For traditional forging operations die change and setup steps can be defined in 5 main steps as following:

- Preparation: This is the first step towards die changing in which we have to ensure that all the dies are designed properly.
- Mounting & Dismounting of dies: In this step, it involves removal of the dies and the related apparatus after production lot is completed and placement of new die sets.
- Establishing Control Settings: All kinds of settings including calibrations and measurements such as centering, measuring temperature and so forth are involved in this step of die setup.
- First Run Capability: This includes necessary adjustments (re-calibrations, additional measurements) required after first trial pieces are produced.
- Setup Improvement: This is the final step of die changing in forging hammer in which we include the time after processing during which the dies are cleaned, identified, and tested for functionality prior to storage.

As we survey about some industries which are related with forging the time for die setup is 2.5hr to 4hr. During this time period, the press remains idle. So, during this time there is no production. So, for removing this barrier they require one concept i.e. SMED.

1.4 Time Losses during Die Changes

The most irritating thing in traditional die changing method is that during the die changing and setup operations, the forging presses are retained in no working condition i.e. idle. An unproductive time, since the forging presses are not working during the time spent for mounting and dismounting of die sets into the forging press.

The most time-consuming operation of die changing and die setup is to adjust the vertical axis of the die. In die setup operation, more than 50% time is consumed during this setup of the vertical axis of the die. The workers face difficulty and require more experience to set this vertical axis. After the trial tests, it is generally necessary to disassemble the whole die set from the press and mount them again.

There are also many other problems which are regarding with die setup and changing which is time-consuming and also affect the productivity of the industry. So, for quick die setup, we require SMED concept.

In this literature review, we study about the concept of SMED in forging die.

2 LITERATURE REVIEW

2.1 Lean Manufacturing

Lean may be a way [1], a process, a set of principles, a set of tools and techniques, an approach [2], a concept [3], a philosophy [7], a practice, a system, a program, a manufacturing paradigm [4], or a model. [5]

The scope of LM includes product development, operations management, total supply chain [7], human design element [3], manufacturing paradigm, market demand, and environment changes [4].

Various goals for which LM is implemented are – [5]

- To get a large variety of products with fewer defects.
- To integrate product development, supply chain management, and operation management.
- To reduce cost/produce more with less.
- To reduce time to delivery.
- To level the production schedule.
- To improve quality at low cost.
- To remove waste from the system.
- To maximize capacity and minimize inventory.

- To improve productivity and to achieve agility etc.

So, for implementation of just in time method in forging and we want an accuracy in the production we must know about the basic concept of lean manufacturing. At a certain level of some implementation of SMED, this concept is helpful.

As per the study of the literature review if we applied the lean manufacturing in the forging process then there is a significant improvement we get in the production and we also reduce the waste time.[8]

Table 1 Definition of Lean Manufacturing in Different Research Papers

Sr. No.	Author	Definition of lean manufacturing
1	Krafcik (1988)	Compared to mass production it uses less of everything half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products
2	Storch and Lim (1999)	Lean production is an efficient way to satisfy customer needs while giving producers a competitive edge
3	Shah and Ward (2003)	Lean manufacturing can be best defined as an approach to delivering the utmost value to the customer by eliminating waste through the process and human design elements. Lean manufacturing has become an integrated system composed of highly inter-related elements and a wide variety of management practices, including Just-in-Time (JIT), quality systems, work teams, cellular manufacturing, etc.
4	Shah and Ward (2007)	Lean is a management philosophy focused on identifying and eliminating waste throughout a product's entire value stream, extending not only within the organization but also along its entire supply chain network
5	Alves et al. 2012	Lean production is evidenced as a model where the persons assume a role of thinkers and their involvement promotes the continuous improvement and gives companies the agility they need to face the market demands and environment changes of today and tomorrow

2.2 5S System

5S is a framework to decrease squander and upgrade efficiency through keeping up a precise work environment and utilizing visual pieces of information to accomplish more steady operational outcomes [9]. Usage of this strategy "tidies up" and arranges the working environment essentially in its current design. The 5Smethodisa planned system to implement work place organization and standardization.

The 5Ssystem has been developed in Japan at Toyota. It is called 5S, sinceall steps start with an "S":Seri, Seiton, Seiso, Seiketsu, and Shitsuke. Also in English, the methodcanbereferredtoas5S: [10]

Sorting alludes to the act of sorting through every one of the devices, materials, and so forth, in the work region and keeping just fundamental things. Everything else is put away or disposed of. This prompts to fewer perils and less mess to meddle with gainful work.

Settingin Order focuseson the need for an orderly work place. Apparatuses, tools, and materials must be deliberately organized the simplest and most proficient get to. There must be a place for everything, and everything must be in its place.

Shining demonstrates the need to keep the working environment spotless and in addition flawless. It manages cleaning and assessing to keep apparatuses and machines in great condition. After every operation, the work zone is tidied up and everything is reestablished to its place.

Standardizing allows for control and consistency. The visual administration is a critical angle to encourage simple comprehension of these measures. Fundamental measures apply wherever in the office. Everybody knows precisely what his or her duties are. Housekeeping obligations are a piece of normal work schedules.

Sustaining is the continuous process of improvement and further refinement of the standard sand the communication with all employees.

The 5Sprovidea methodology for organizing, cleaning, developing and sustaining aproductive work environment. In the daily work of a company, routines that maintain organization and orderliness are essential to a smooth and efficient flow of activities. This lean method encourages work ersto improve the irworking conditions and helps the mtolearn to reduce waste, unplanned down time, and in-process inventory. [10]

2.3 Quick Die Locating Methods

If quick die changing and setup repeatability are aimed to be performed, a repeatable die locating method is essential. It should not depend upon complicated measuring or trial and error methods. Following methods are some of the popular die locating techniques. [11]

2.3.1 Pin Locators

Pin locators are the very common application of locating dies. In this method, for inserting pins at the bottom surface of the die has one round hole and one slotted hole. In this method, two pins are utilized for locating the die. When the first pin is engaged in the slotted hole of the die, the exact locating is obtained by locating the second pin into the round hole of the die. Below figure illustrate the pin locators used in locating the forging die.

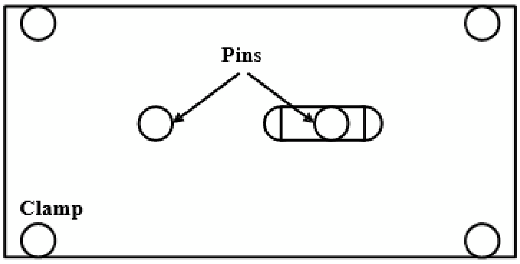

Figure 1 Pin Locators

2.3.2 V Locators and Flat Pocket

In this method, we provide a V-slot and flat pocket in the die. Die to locate is completed by using two pins which are spaced at fixed locations on the die holder of the press. In this method, first of all, we locating one pin to the flat pocket and then exactly the same pin we use for V-slot. Figure 2 illustrates this application. As per our requirement the size of the die is different. So, for locating the different dies in the same press we require different holes to be provided in the die holder. So, according to the width of the die, the pins can be moved to desired pair holes on the die holder.

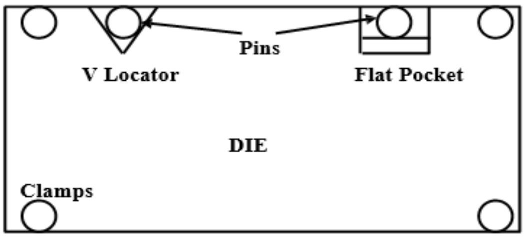

Figure 2 V locators and Flat Pocket

2.3.3 Locating Die Block Front to Back

The figure illustrates system of locating a diefront-to-back by means of a keywaymilled in the dieholder. A widerkeywayismilled In the bottom surface of the die, to permite as yengagement of the key.

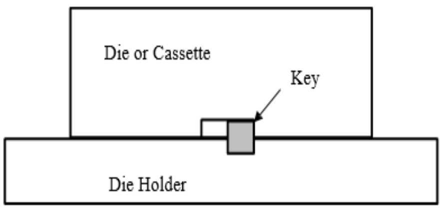

Figure 3 Locating Die Block Front to Back

2.3.4 Other Examples of Clamping Dies

When developing fastening techniques, the key element deceits in distinguishing the role of engaged threads. Their purpose is to preserve friction equivalent to the clamping pressure.

Figure 4 [11] illustrates four examples of commonly used die securing methods. In those examples, we include a number of spaces blocks, one piece clamp, constant height clamping ledges and forged steel clamps.

With respect to process applications, shop rules, stacking conditions and gear feasibility, not these strategies might be appropriate for a given application.

Terrible cases of securing can some of the time be experienced in the industry. However, a large portion of the organizations is attempting to prohibit these practices by protection overseers and their organization rules.

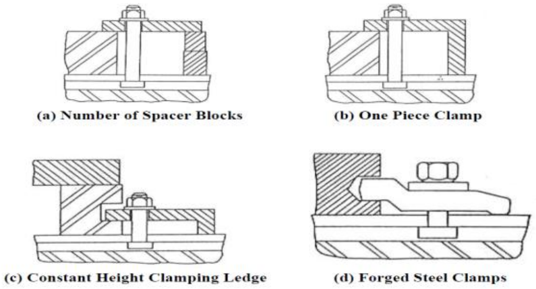

Figure 4 Examples of Die Clamping Methods [11]

Figure 5 [11] illustrates four examples of those bad die clamping methods. The examples include strap installed backward, hole in clamp too large, nuts and extra washers to permit a long bolt usage and improper spacer blocks. None of these examples should be permitted in any industrial application.

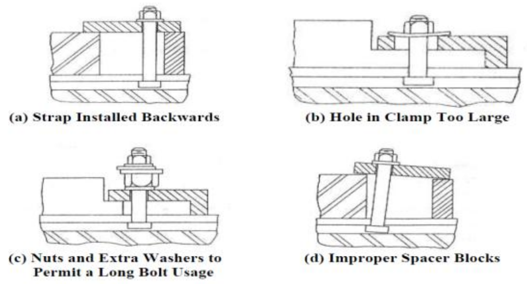

Figure 5 Examples of Improper Die Clamping Methods [11]

2.4 Single Minute Exchange of Die (SMED)

Single-Minute Exchange of Die (SMED) alludes to the hypothesis and methods utilized for the lessening of equipment setup times. SMED has as its target to finish setup times in under ten minutes, i.e. various minutes communicated by a solitary digit. Despite the fact that not all setups can be actually decreased to this time, in the vicinity of one and nine minutes, this is the objective of the SMED strategy. [11]

SMED, also known as Quick Change Over of Tools, was developed by Shingo (1985) [11], who described it as a logical approach for the lessening of setup times, and which can be connected to any modern unit and for any machine. SMED is characterized as the base measure of time important to change the sort of generation action thinking about the minute in which the last bit of a past parcel was delivered versus the main piece created by the consequent part [11]. Before the development of the SMED methodology, the best way to minimize the cost of idle machines during setup operations was to produce large lots, in order to obtain the lowest possible percentage of idle time per unit produced.

Toyota came across this problem because inventory costs for their vehicles were extremely high. Prior to this issue, an ideal approach to lessen the measure of generation misfortune was to diminish setup times [11]. Accordingly, if production changes should be possible in less time, the perfect measure of creation could be littler, which, thus, would diminish the costs included. The question around the ideal measure of the production lot stays as it is important to figure the base sum for every production lot. The production of extensive lots likewise has intrinsic capital expenses with the sum put resources into stock. If we add to this inventory cost the capital opportunity cost, it is no longer profitable to produce large lots.

The first definition of SMED was described by Shingo in 1985 into following four stages which are described as below:-[12]

- 0th Stage: - Internal and External setup are not separated.
- 1st Stage: - Separating Internal and External setup.
- 2nd Stage: - Converting Internal setup to External setup.
- 3rd Stage: - Streamlining all aspects of the set-up operation.

As here the 0th stage is the statement of the original situation. Shingo defines the SMED process in main three steps i.e. separating internal and external setup converting internal to external set-up; streamlining all aspects of the set-up operation.

There are certain terms which are required to study the SMED concept which is described as below:

- Batch: - it is the quantity of the products which is produced together. [13]
- Changeover: - it is the process of switching from production of one product to the production of another product. Changeover time is measured as the time slipped by between the last pieces in the run simply finished until the primary great piece from the procedure after the changeover. [13]
- Downtime: - it is the production time lost due to the planned and unplanned stoppage. In planned stoppage, they include such activities as production meeting, scheduled maintenance, and change over time. In unplanned stoppage, they include machine breakdown, worker's strike, material absence, machine adjustment etc. [13]
- Lean Production: - Lean production is an efficient way to satisfy customer needs while giving producers a competitive edge. [13]
- Non-value added activities: - these are those activities which consume the time and cost in the production but it does not add value to customer's perspective. These are those activities for which customer will not ready for pay it. [13]
- Setup: - the process of switching from one part production to the production of another product by removing all dies, tools, pins and every assembly which is related with it and assemble new setup for new production. [13]
- Setup Reduction: - it is the process of reducing the setup time. [13]
- Value added activities: - The time spent on exercises that enhance a thing from the client's viewpoint. These are exercises that viable change the shape and capacity of a crude material into a decent or administration that the client will pay for. [13]
- Value stream map: - it is the diagram in which it shows the complete flow of material from storage to the final product. [13]
- Waste: - any activity which consumes resources but it does not add value to the customer perspective. [13]
- Adjustment waste: - Any exercises that would bring about the machine to cycle in a test or trial mode which could make a section that must be assessed and after that conceivable rejected or rephrased. [14]
- Die set: - it is the main element of the forging press. It is the set in which two dies are involved upper die and the lower die. This upper die and lower die makes the die set. [14]
- External setup: - it is that part of setup which can be done while the machine is in running condition. For example, preparing a die to be used for next run. [14]
- Internal setup: - it is that part of setup which can be done while the machine is not in running condition i.e. in an idle condition or non-working condition. For example, removing the die from the die holder. [14]
- Setup Waste, External: - Activities such as searching, locating or moving jigs, tools, bolts, clamps, fasteners, gauges or instructions in the setup area. [14]
- Setup Waste, Internal: - Alignment activities required to remove and install tools, for example, the time associated with using a fork truck to maneuver the old tool out and the new tool in while setting up a press. [14]

Now here we illustrate three major step of SMED in details and how we can apply to the forging industry.

2.4.1 Stage 1:-Separating Internal and External Setup:

Identifying the internal and external setup operations is the most important step in implementing SMED. In this stage, the undertakings that can be performed while the machine is running are recognized from the task that can be completed when the machine is stopped. Some specific undertakings like repairs, taking the fundamental apparatuses closer and arrangement of bites the dust and devices can be completed before the machines are stopped. At this stage alone, changing over these undertakings to outside setup can decrease changeover time as much as 30 to 50 %.

According to SMED, three real-world methods are used to distinct internal and external setup tasks. These are: [11]

- Checklists: They are arrangements for goodness' sake required for setup; Checklists can incorporate basic instruments, details, working conditions, required laborers and so forth.
- Function Checks: They give data about the parts whether they are in impeccable working condition. Repairs of dies and different instruments ought to be performed before the inside setup. Something else, deferrals will happen in inner setup.
- Improved Transportation of Dies and Tools: All dies, shoes and required tools should be transported to the machine before the machine is stopped for the changeover. Similarly, old dies and unnecessary tools should be put away, after the machine is started for the new production.

2.4.2 Stage 2: - Converting Internal Setup to External Setup:

When converting internal activities to external ones, the following two items should be considered. First one is reexamining the operations and checking the true functions of each operation to find out if this operation is mistakenly or unconsciously set in internal setup. The second one is trying to find ways to convert these internal setup operations to external ones.

Following three real-world methods are used to convert internal setup steps to external setup steps [11].

- Advance Preparation of Operating Conditions: It guarantees that every single vital part, devices, and natural conditions are prepared before the inside setup operations start. Conditions like temperature, weight and material positions can be arranged remotely when the machine is working.
- Function Standardization: Standardization means keeping something the same from one operation to another. When tools or machine parts are different from those in the previous one, operators have to perform time-consuming adjustments during changeovers. Standardization can be applied to dimensioning, centering, securing etc.
- Intermediate Jigs: They are the frames or plates that have standard dimensions. Generally, two identical jig plates are prepared and used. While the die is fastened to one of these jigs and used on the machine, the next die is centered and attached to another jig as an external setup procedure. When the operation with the first die is finished, the jig which it is attached is removed from the press and the second jig with the next die is mounted to the press.

2.4.3 Stage 3: - Streamlining All Aspects of Setup:

In this stage, the capacity and reason for every operation are inspected once again and the fundamental components of setup are investigated in detail. Streamlining all inner and outer setup operations implies enhancing those procedures. Particularly, particular time shortening techniques are connected to inward setup operations, when the machine is not working.

The real-world methods for streamlining applications can be classified into two categories. Those are streamlining external setup and streamlining internal setup.

- Streamlining External Setup: Sorting out the tools, dies, jigs and gauges required for die setup, keeping up the strategies to keep those things in flawless conditions, anda number of those things to be put away are a portion of the matters that can be considered deliberately and created amid outside setup. Disentangling the capacity, enhancing the transportation of the tools and dies are a few cases of this stage.
- Streamlining Internal Setup: This step is the key point of time reductions because the reduction in changeover time strongly depends on shortening the time spent for internal setup operations. Implementing parallel operations, using functional clamps, eliminating adjustments and mechanization are the techniques used for improving internal setup operations.

Shingo applied SMED concept in some industries and he got aresult there is an ultimate change in the die setup time. Below table indicates the time for die setup in different industries.

3 Conclusion

So, by studying this we conclude that for increasing the productivity and applied themethod of Just-in-time production in forging industries. There are various methods for improving the production. In applying the concept of lean production we reduce the unwanted time-consuming methods which are used in the production. Then if we apply the 5S system in the production system then we must follow this 5S: Shorting, Setting in order, Shining, Standardization, and Sustaining. Then there are various quick die locators which are used in thediesetup as astudy in chapter no. 2. Then the most effective method is SMED. In this method, we study that there are two most important thing which is used in SMED is external setup and internal setup. By studying this paper we know about how to we separate the internal and external setup and how we convert internal setup to external setup.

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