ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
School of Mechanical, Chemical and Materials Engineering

Design and Manufacturing of Concrete Mixing Machine

A Project submitted in partial fulfillment of the requirements for the award of the degree of

Master of Science
in
Manufacturing Technology Teachers' Education

By

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Department of Manufacturing and Vehicle Engineering

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Adama

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DECLARATION

We hereby declare that the work which is being presented in the project entitled "**Design and Manufacturing of Concrete Mixing Machine"** in partial fulfillment of the requirements for the award of the degree of Master of Science in Manufacturing Technology of Technical Teachers' Education is an authentic record of our own work carried out from March 2015 to May 2015 under the supervision of School of Mechanical and Chemical Engineering, Department of Mechanical and Vehicle Engineering, Adama Science and Technology University, Adama-Ethiopia.

The matter embodied in this project has not been submitted by us or others for the award of any other degree or diploma. All relevant resources of information used in this thesis have been duly acknowledged.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge and belief. This project has been submitted for examination with my approval.

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LIST OF ABBREVIATIONS AND ACRONYMS

AC:	Alternate Current
ASME:	American Society of Mechanical Engineering
ASTU:	Adama Science and Technology University
COV:	Coefficient of Variation
DC:	Direct Current
HRWRA:	High Range Water Reducer Admixture
RILEM:	Re'union International des Laboratories d' Essais et de Recherches sur les Mate'riaux et les constructions
RPM:	Revolution per Minute
SEM:	Scanning Electron Microscope
SME:	Small and Micro Enterprise
TVET:	Technical and Vocational Education and Training
WF:	Weight Factor

Abstract

A typical concrete mixer uses a revolving drum to mix the components. Mixing concrete is a combining process in which aggregate/gravels, grits, stone chips, cement and water is revolving up and down using radial or centrifugal force and mix simultaneously in a drum to make concrete. Concrete is a substance used for building and construction industry which is made by the mixture of cement, stone chips, and water. Now a day concrete mixing process using mixer machine can be time saving and applicable in every construction sites from small scale to large scale level. Small scale construction enterprises are owned by individual entrepreneurs, firms, and shareholders currently involved in fabrication of dam, irrigation and etc. and thus the mixer we produced considered as its efficiency is good, the machine performance and mixing time is 150-200kg with in 10min or 930 kg per hour. When using manual, the human power delivered to 50kg in 10 min mixing rate is minimized from relative to the power.

Construction site workers expressed their feeling through questionnaire we provided them if their organization can get mixer machine with a reasonable price for the ease of mixing. According to their response most of the time they are mixing or producing concrete by the oldest method, which is using shovel. In this (oldest method) operation the time required to provide concrete is much greater than expected and uses more and more manpower. Therefore, to make the gap narrower we made a design and produced the machine with local materials, easily movable mechanisms, optional operation design that is using manual in operation with the machine when electric power is interrupted without the delay of mixing time and etc in order to produce homogenous mixture of concrete with very attractive and reasonable selling price of 24,844.215 Ethiopian birr. The machine was tested for its functionality and no unexpected or exaggerated problem is observed except machining speed variation than expected using three phase 2hp electric motor. Meaning the speed is slightly higher than designed and we recommend using electric motor of lesser power or hp. If urban and rural development experts at different levels and stakeholders create awareness for easy dissemination of the technology in to rural areas because the machine was designed to work electrically and manually, part of the problems of construction and building industry may be minimized as our understanding.

Key words:- Concrete mixer, mixer efficiency, homogenous mixture etc.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Some form of concrete, the mix of a binder, aggregate and water, has existed since the dynasties of the Egyptian pharaohs when water, sand and lime were mixed to use as mortar in building sections of the pyramids. Romans also used a form of concrete in constructing their aqueducts, the Coliseum and other major constructions. Scientists in the 1800s began experimenting and perfecting hydraulic cement, which is what the construction industry still uses today. The name for Portland cement came from the Isle of Portland, off the English coast, where deposits of the mineral components used in modern concrete were first found and chemically isolated. By 1908, Thomas Edison was experimenting with building pre-cast concrete houses in Union, N.J. Most of those houses are still standing and being used. Then there are the famed Hoover and Grand Coulee dams, built in 1936, that stand among the wonders of the world.

Stephen Stepanian developed and applied to patent the first motorized transit mixer in 1916, in an effort to replace the horse-drawn concrete mixer used at the time. Wooden paddles churned the mixture as the cart wheels turned, but the design was of limited use. It was cumbersome and slow. The same, however, could be said of the engines and trucks during that period. But by the 1940s, engines and truck-frame construction caught up to the need for a rugged vehicle capable of hauling thousands of pounds of wet, or unset, concrete. As the building boom following World War II went into full swing, mixer trucks came into their own.

The large drum mixer seen on roads today hasn't changed much from Stephanie’s vision of a better concrete hauler. Mobile transit mixers are a mix-and-match selection of engine, truck frame and rotating mixer. The mixer is similar, though larger in scale, than the smaller ones found on construction sites. A large motor, separate from the engine, rotates the drum on the truck body, and a series of blades or a screw powered by the same motor keeps the aggregate, water and cement in constant motion. This keeps the premixed concrete from setting, though the clock is often ticking to get the load to the construction site, road section or parking lot. Most cement manufacturers suggest keeping the time between mixing and pouring to 90 minutes at most. It's even better to get it to the site in less than an hour.

As technology has changed, so has the basic mixer design. While many transit mixers still have rotating drums, most don't simply pick up a load of wet cement and transport it.

Most transit mixers have a separate water tank in the truck. The spinning drum keeps the dry ingredients, aggregate and cements mixing during most of the trip. When the driver is within a few miles of the site, water is added to create concrete fresh for delivery.

This is considered "batch" delivery of ready-mixed concrete, mixing ingredients off site and trucking them where they're needed. Advances in technology have made it possible to mix concrete at the job site, though transit mixers are still the workhorse of the field.

Volumetric and metered mixers are becoming more common. Both types are essentially on-site custom concrete plants. Separate holding tanks of aggregate, cement and water are contained in one truck with a computer hooked to augers and pumps. At the site, the customer can order a specific type of concrete (there are more than a dozen) that can be mixed by the truck.

Volumetric and metered mixers are often used during high-rise construction and can be paired with pumper trucks to deliver concrete more than 15 stories above the ground.

A concrete mixer also commonly called a cement mixer is a device that homogeneously combines cement, aggregate such as sand or gravel, and water to form concrete. A typical concrete mixer uses a revolving drum to mix the components. For smaller volume works portable concrete mixers are often used so that the concrete can be made at the construction site, giving the workers ample time to use the concrete before it hardens. An alternative to a machine is mixing concrete by hand. This is usually done in a wheelbarrow; however, several companies have recently begun to use modified tarps for this purpose.

Concrete is mixed either by hand or machine. No matter which method is used, one must follow well-established procedures if expected finished concrete of good quality. But an oversight in proper concrete mixing, whether through lack of competence or inattention to detail, cannot be corrected later. Therefore, in order for proper mixing procedure it is advisable to use the right mixing machine. Based on the above fact we are going to manufacture a well adjusted and easily affordable and even manageable through electrical and manually operated concrete mixer for the construction industry.

1.2 Statement of the problem

With the development and transformation of society from a global perspective concrete mixer development, in the early stages of industrial, concrete mixer manufacturing industry is the main industry; and in the middle and late industrialization, services gradually become the main industry. Today, concrete mixing machine companies have entered a "post-industrial era", relying on the advantages of brand and manufacturing services and other charges in the global high-end market advantage.

Mini concrete mixer companies build service system, not just in improving hardware and management level, more importantly, efforts to improve the quality of personnel concrete mixer equipment marketing and technical services team, the company initiated a "customer first" and for customers to create the greatest value of the concept, the combination of the depth of manufacturing and services. Innovation around the core product or core competencies, and service combine to achieve better development. Thus in our country concrete mixer machine was imported from the developed countries with high amount of foreign currency cost, either heavy or small duty concrete mixer machine except Kality metal work factory, Abe engineering(Adama), and defence engineering found in Ethiopia are producing it with 100% copying. Still there is no an appropriate modification and production of mixer related to cost reduction phenomena. This is happened by various factors, like the privation of appropriate technology related to produce concrete mixer machine in domestic level, the machine required complex manufacturing process, maintainability, operation, well trained man power etc. so the micro enterprise and TVET institution are not engaged in producing concrete mixing machine.

Our project is expected to find solution for the problems occurred in small scale construction enterprises in making concrete rather than traditional way and to improve the quality of concrete by avoiding dusts and impurities that could be mixed during mixing. Most construction workers mix concrete on the floor using shovel due to unavailability of proper mixing machine. The concrete obtained by this process lack quality and homogenous mixture.

We modified the existing concrete mixer due to the following;

- Machines require high cost either to purchase or manufacture.
- The time required in regulating and setting the machine is comparatively higher.
- There was no study made to produce or manufacture the machine in TVET and by most micro enterprise workshops.
- It is difficult or need some load carrying machines or cars to move from place to place.

Therefore, in order to minimize the stated problems above we produced a tilt drum type concrete mixer machine.

1.3 Objectives

1.3.1 General Objective

The overall objective of this project is to improve the design, size, maintenance and Manufacturing of a concrete mixing machine.

1.3.2 Specific objectives

The following are the specific objectives of the project:

- Identify problems related to the machines based on suppliers and users feed-back.
- To produce a machine with a minimum cost
- To select materials according to the specification
- To select manufacturing process suitable for the project
- To Inspect and test the project to ensure its functionality

1.4 Significance of the study

The concrete mixer we produced can have several purposes when compared to the other and heavy duty mixer machine: therefore, it is:

- Easy to operate
- Lesser maintenance
- Easy to move from place to place
- Easy to produce and transfer to small and medium scale enterprises.
- It is easy to operate, durable and have a longer functional life. It has a lesser cost of maintenance and will be available in the leading industrial price if transferred to SME.

1.5 Scope of the Project

We designed and manufactured manual and electrically operated concrete mixing machine. The mixing process can be set electrically using 2hp single phase electric motor and manually by free hand with the help of crank shaft or, in short, handle when an electric power is not available in the site by considering human ergonomic factors. Our target community for a proof-of-concept design is the construction center or industry or small scale micro enterprise (MSE) and private construction industry engaged in production of concrete for building or construction purpose.

1.6 Limitations

Budget constraint is one of the problems we faced to start the project on time in order to complete successfully within the schedule of the university. Besides, shortage of raw materials in the market and time constraints due to unpredicted occasions existed is the other. Searching for the right material and standards from local market and unavailability and poor working conditions of machines also taken much time and money than we expected. We added some amount to what we budgeted due to transportation cost for looking the right materials and standards (from Adama and Addis Ababa) and inflation of materials' price are some of the limitations we faced.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

As for all materials, the performance of concrete is determined by its microstructure. Its microstructure is determined by its composition, its curing conditions, and also by the mixing method and mixer conditions used to process the concrete. The mixing procedure includes the type of mixer, the order of introduction of the materials into the mixer, and the energy of mixing (duration and power). To control the workability of the fresh concrete, for example, it is important to control how the concrete is processed during manufacture.

In this overview, the different mixers commercially available have been presented together with a review of the mixing methods. Further, the advantages and disadvantages of the different mixers and mixing methods and their application were examined. A review of mixing methods in regards to the quality of the concrete produced and some procedures used to determine the effectiveness of mixing methods were also given.

The methodology to determine the quality of the concrete mixed is often referred to as the measurement of the efficiency of the mixer. The efficiency parameters of a mixer are affected by the order in which the various constituents of the concrete are introduced into the mixer, the type of mixer, and the mixing energy (power and duration) used.

2.2 On-site and portable concrete mixers

For smaller jobs, such as residential repairs, renovations, or hobbyist-scale projects, many cubic yards of concrete are usually not required. Bagged cement is readily available in small-batch sizes and aggregate and water is easily obtained in small quantities for the small work site. To service this small-batch concrete market, there are many types of small portable concrete mixers available.

A typical portable concrete mixer uses a small revolving drum to mix the components. For smaller jobs the concrete made at the construction site has no time lost in transport, giving the workers ample time to use the concrete before it hardens.

Portable concrete mixers may be powered by a gasoline engine, although it is more common that they are powered by electric motors using standard mains current.

These concrete mixers are further divided based on their loading mechanism. Cement, sand and other aggregates are loaded in a hydraulically operated hopper and then poured in the mixing drum for final mixing and then can be unloaded by tilting the drum. While in Hand Feed Concrete Mixers, cement, sand and other aggregates are directly added to the mixing drum manually. These both type of concrete mixers are highly popular and used in regular construction activities in Africa, some Middle Eastern Countries and in the Indian subcontinent.

Figure 2.1 Portable site concrete mixer[15]

This portable concrete/mortar mixer has wheels and a towing tongue so that it can be towed by a motor vehicle and moved around the worksite by hand, and its rotation is powered by mains electricity. The lever allows the concrete/mortar to be tipped into a wheelbarrow.

Figure 2.2 An outdated model of a small scale concrete mixer[15]

These older mixers are heavy and cannot be moved as easily. They are still self powered with an electric motor.

2.3 Hardware: the Mixers

There are two main categories of mixer: batch mixers and continuous mixers. The first type of mixer produces concrete one batch at a time, while the second type produces concrete at a constant rate. The first type needs to be emptied completely after each mixing cycle, cleaned (if possible), and reloaded with the materials for the next batch of concrete. In the second type, the constituents are continuously entered at one end as the fresh concrete exits the other end. The various designs of each type of mixer will now be discussed.

2.3.1 Batch Mixers

Two main types of batch mixer can be distinguished by the orientation of the axis of rotation: horizontal or inclined (drum mixers) or vertical (pan mixers). The drum mixers have a drum, with fixed blades, rotating around its axis, while the pan mixers may have either the blades or the pan rotating around the axis.

2.3.1.1 Drum Mixers

All the drum mixers have a container with a cross section similar to that shown in Figure 2.3. The blades are attached to the inside of the movable drum. Their main purpose is to lift the materials as the drum rotates. In each rotation, the lifted material drops back into the mixer at the bottom of the drum and the cycle starts again. Parameters that can be controlled are the rotation speed of the drum and, in certain mixers, the angle of inclination of the rotation axis. There are three main types of drum mixers:

• non-tilting drum;

• reversing drum;

• tilting drum.

The non-tilting drum mixer implies that the orientation of the drum is fixed. The materials are added at one end and discharged at the other (Figure 2.4).

The reversing drum is similar to the non-tilting mixer except that the same opening is used to add the constituents and to discharge concrete. The drum rotates in one direction for mixing and in the opposite direction for discharging the concrete. There are two types of blades attached to the inner walls of the drum. One set drags the concrete upwards and toward the center of the mixer when the drum rotates in one direction; the second set of blades pushes the concrete toward the opening when the drum rotates in the other direction. The blades have a spiral arrangement to obtain the desired effect for discharge and mixing. Reversing drum mixers are usually used for batches up to 1 m3 [1].

The truck mixers belong to the reversing category of drum mixers. The driver of the truck can control the speed of rotation with a clutch in the cabin. The speed depends on whether the concrete has been well mixed prior to being placed in the truck or whether the truck has to do most of the mixing. Typically the speed for mixing is 1.57 rad/s (15 rpm), while the transport of pre-mixed concrete uses only 0.2 rad/s (2 rpm) to 0.6 rad/s (6 rpm) [1]. In the United States, most ready-mixed concrete is mixed in trucks [2] and not pre-mixed in a plant.

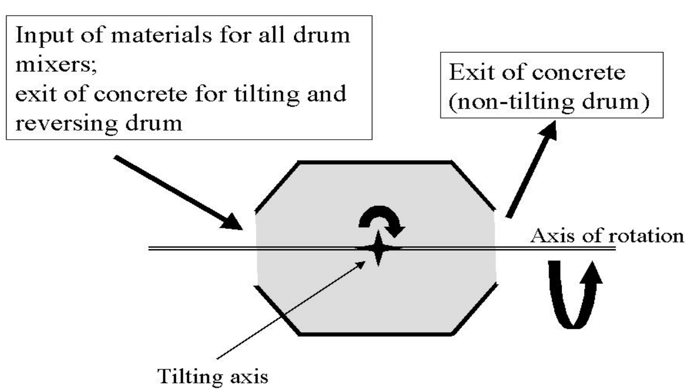


Figure 2.3 Cross section of drum mixer[2].

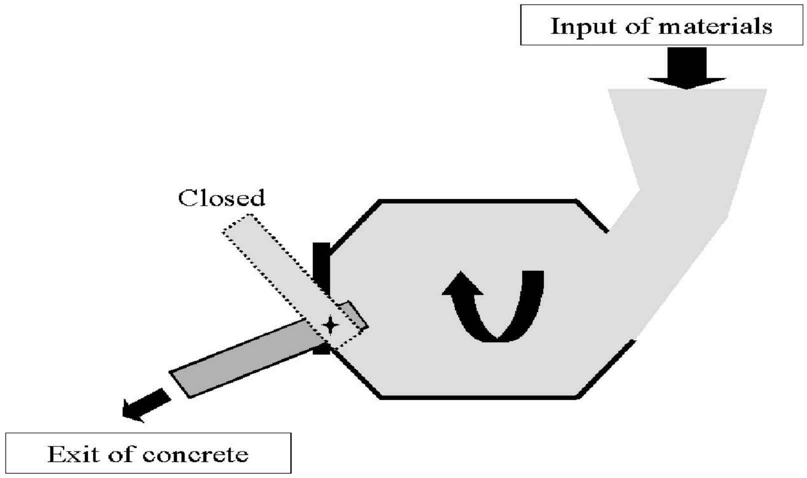


Figure 2.4 Cross section of a non-tilting mixer [1].

In a tilting drum mixer (Figure 2.5), the inclination can be varied. When the drum is almost horizontal (inclination ≈ 0^0), more energy is provided to the concrete because more concrete is lifted to the full diameter of the drum before dropping. It is during the drop that the concrete is knitted and mixed. Therefore, the higher the drop, the higher the energy imparted to the concrete. If the axis of rotation is almost vertical the blades cannot lift the concrete and the concrete is not well mixed. The drum axis usually stays at an angle of about 15 degree from the horizontal during mixing. To discharge the concrete the drum is tilted downwards (Figure 2.5) below the horizontal plane.

The tilting drum is the most common type of drum mixer for small batches (less than 0.5 m3) both in the laboratory and in the field [1].

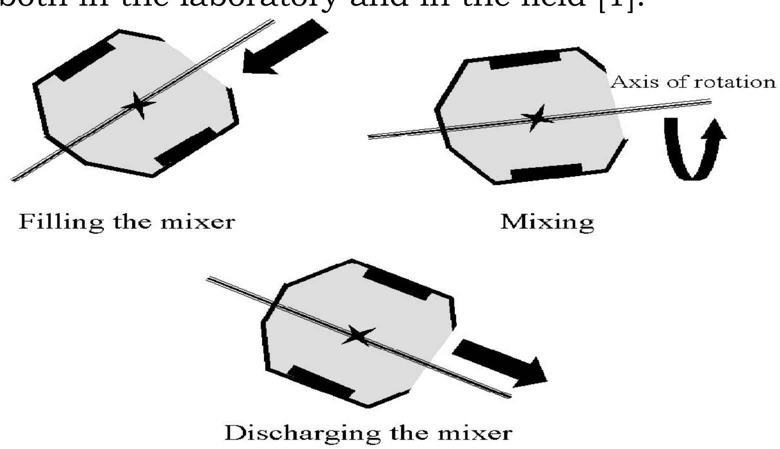


Figure 2.5 Cross section of a tilting mixer[1].

2.3.1.2 Pan Mixers

All pan mixers work on basically the same principle [3]: a cylindrical pan (fixed or rotating) contains the concrete to be mixed, while one or two sets of blades rotate inside the pan to mix the materials and a blade scrapes the wall of the pan. The shapes of the blades and the axes of rotation vary. Figure 2.6 shows the different combinations of blade configurations and pan. The other element of the mixer is the scraper. Sometimes the axis of rotation of the blades coincides with the pan axis (single paddle mixer, Figure 2.6a and b). Other pan mixers have the axis offset [planetary motion mixer and counter-current motion (Figure 2.6d and e)]. In these cases (Figure2.6d and e), there are two rotations: the blades rotate around their axes and around the axis of the pan (arrow 2 in Figure 2.6d and e). The other possibility is to have two shafts that rotate in a synchronized manner [dual shaft (Figure 2.6c)]. This is a blade that is suspended at an angle near the inner wall of the pan. Its role is to scrape the concrete that tends to stagnate near the wall of the pan from the wall and to push it inward so that it encounters the rotating blades. If the pan is rotating, the scraper can simply be fixed, i.e., suspended near the wall of the pan and not moving. If the pan is fixed, the scraper must move to push concrete toward the blades. Usually the individual moving parts, i.e., the blades, the pan, and the scraper, are independently powered. To discharge the mixer, the pan is usually emptied through a trap on the bottom. For small mixers (less than 20 L or 0.02 m3), the blades are lifted and the pan can be removed to empty the mixer.

2.3.2 Continuous Mixers

The second category of mixers is continuous mixers [4]. As the name indicates, the materials are continuously fed into the mixer at the same rate as the concrete is discharged. They are usually non-tilting drums with screw-type blades rotating in the middle of the drum. The drum is tilted downward toward the discharge opening. The mixing time is determined by the slope of the drum (usually about 15^0). These mixers are used for applications that require a short working time, long unloading time, remote sites (not suitable for ready-mix) and/or small deliveries. A major use of these types of mixers is for low slump (non flow-able [5]) concretes (e.g., pavements). Due to the short mixing time, the air content is not easily controlled even with the addition of air entraining admixtures [6].

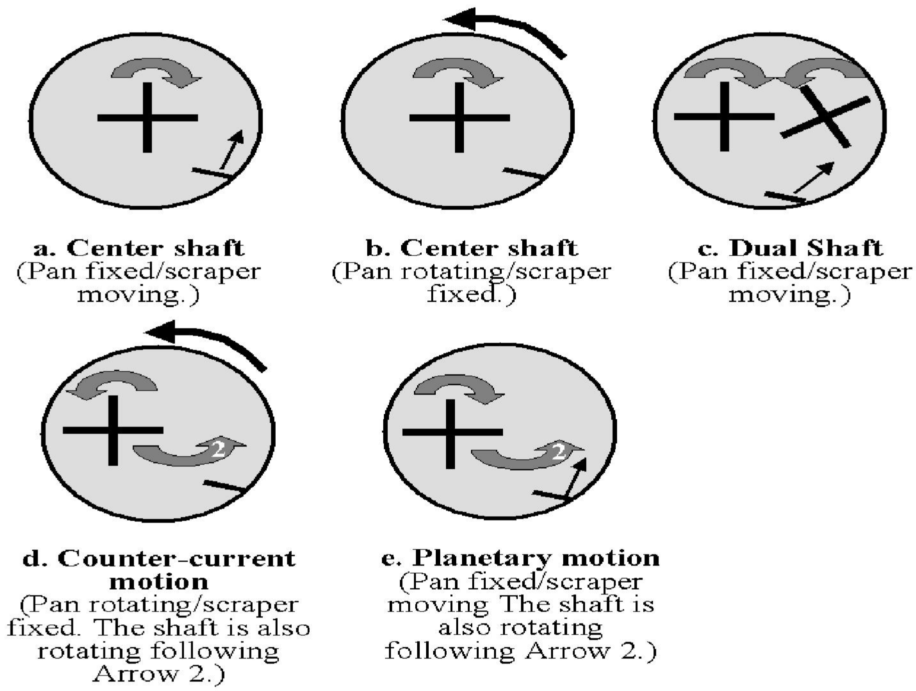


Figure 2.6 Various configurations for pan mixers. The arrows indicate the direction of rotation of the pan, blades, and scraper[6].

2.4 Mixing Method

In describing the mixing process, the mixer hardware is only one of several components. The mixing process also includes the loading method, the discharge method, the mixing time, and the mixing energy.

2.4.1 Loading, Mixing, and Discharging

The loading method includes the order of loading the constituents into the mixer and also the duration of the loading period. The duration of this period depends on how long the constituents are mixed dry before the addition of water and how fast the constituents are loaded.

The loading period is extended from the time when the first constituent is introduced in the mixer to when all the constituents are in the mixer. RILEM (Re´union Internationale des Laboratoires d'Essais et de Recherches sur les Mate´riaux et les constructions) [8] divides the loading period into two parts: dry mixing and wet mixing (Figure 2.7). Dry mixing is the mixing that occurs during loading but before water is introduced. Wet mixing is the mixing after or while water is being introduced, but still during loading. This means that materials are introduced any time during the loading period: all before the water, all after the water, partially before and partially after.

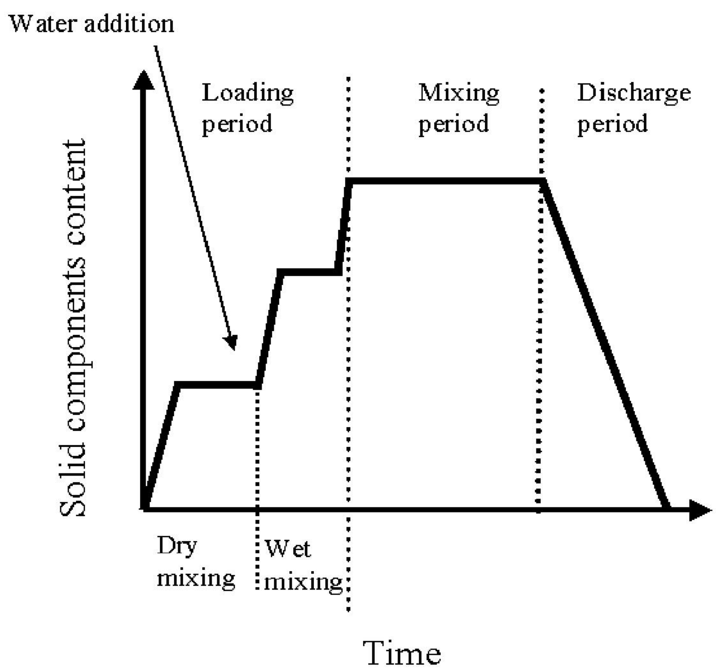


Figure 2.7 Mixing schedule ([8] for further discussion of this graph).

The loading period is important because some of the concrete properties will depend on the order in which the constituents are introduced in the mixer. It is well known that the delayed addition of high range water reducer admixture (HRWRA) leads to a better dispersion of the cement. The same workability can be thus being achieved with a lower dosage of HRWRA [7]. Unfortunately, there is no systematic study, to our knowledge, that has examined the influence of the order of constituent loading on concrete properties. Most operators rely on experience and trial and error to determine the loading order of their mixer.

Very often, the mixing time is defined as the time elapsed between the loadings of the first constituent to the final discharge of the concrete. RILEM [8] took another approach defining mixing time as the time between the loading of all constituents and the beginning of concrete discharge (Figure 2.7). It should be noted that solid constituents can be added at various stages of the loading period: during dry mixing, after water is added, after a second period of mixing (third slope in Figure 2.7). Both definitions are acceptable. In any case, it is important that the mixing process be described fully for each batch of concrete.

The discharge from the mixer should be arranged so that it increases productivity (fast discharge), and it does not modify (slow discharge) the homogeneity of the concrete. For instance, if the discharge involves a sudden change in velocity—as in falling a long distance onto a rigid surface—there could be a separation of the constituents by size or, in other words, segregation [8].

2.4.2 Mixing Energy

The energy needed to mix a concrete batch is determined by the product of the power consumed during a mixing cycle and the duration of the cycle. It is often considered, inappropriately, a good indicator of the effectiveness of the mixer [9, 10]. The reason that it is not a good indicator is because of the high dependence of the power consumed on the type of mixture, the batch size and the loading method [11]. For example, a mixer that has a powerful motor could be used to mix less workable or higher viscosity concretes. The mixing energy could be similar to that of a less powerful mixer but one filled with a more workable concrete.

2.5. Mixer Efficiency

As it has been pointed out, the variables affecting the mixing methods are numerous, not always controlled, and not a reliable indicator of the quality of the concrete produced. There is, therefore, a need for a methodology to determine the quality of the concrete produced as an intrinsic measure of the efficiency of the mixer. The concept of “mixer efficiency” is used to qualify how well a mixer can produce a uniform concrete from its constituents. RILEM [8] defines that a mixer is efficient “if it distributes all the constituents uniformly in the container without favoring one or the other”. Therefore, in evaluating mixer efficiency, properties such as segregation and aggregate grading throughout the mixture should be monitored.

2.5.1 Performance Attributes as Indicators of Efficiency

Since the macroscopic properties of concrete are affected by its composition, it is conceivable that the homogeneity of the concrete produced could be monitored by measuring the performance of specimens prepared with concrete taken from different parts of the mixer or at different times during the discharge. Properties that are often considered are workability of the fresh concrete as defined by the:

- slump;
- density of the concrete;
- air content; and
- compressive strength.

Disadvantage of this method is that it is indirect. It does not directly show that the concrete is homogeneous but only assumes that any potential in-homogeneity affects the properties considered. In addition, it is possible that either the measurement methods selected are not sensitive enough to local changes in composition, perhaps because the samples are too large, or that the properties selected are intrinsically not affected by in-homogeneity. The consistency in the properties is a useful guide but not a definitive indicator of product homogeneity.

It can give a false sense of security about the mixing method used.

2.5.2 Composition as an Indicator of Efficiency

A more direct method to determine the efficiency of a mixer would be to measure the homogeneity of the concrete. This method does not rely on an assumption about the dependency of macroscopic properties on the concrete composition. The measure of the concrete homogeneity can be achieved by determining the distribution of the various solid constituents such as coarse and fine aggregates, mineral admixtures, and cement paste throughout the mixture. However, there are no standard tests to determine homogeneity. Nevertheless, the analysis of samples of concrete taken in various parts of a mixer or at various times during the discharge is usually accomplished by washing out the cement paste and then by sieving the aggregates. By weighing the sample before and after washing out the cement paste, the cement paste content can be estimated. The aggregates collected after the cleaning period are then dried and sieved and their size distribution is analyzed. Because the cement paste is washed out and determined as a whole, there is no provision to determine the dispersion of the mineral admixtures or very fine fillers. As demands for higher performance concretes grow, more precise methods will be needed, such as microscopic observations by scanning electron microscope (SEM), to measure the distribution of the mineral admixtures.

Based on the concept that measuring compositional homogeneity of a mixture can provide evidence of the efficiency of the mixer, RILEM [8] tried to establish a classification of mixer efficiency by defining three classes of mixers: ordinary mixer, performance mixer, and high performance mixer. Each class is defined by the range of four criteria: water/fine ratio, fine content (mainly the cement and other fine powder), coarse aggregate content (between $D/2$ and D, with D the maximum aggregate size) and air content. Several samples (the number is not specified) are taken from the mixer or from the concrete discharge, and the above parameters are measured. The average of all the measurements collected for each parameter and the standard deviation are calculated. The coefficient of variation (ratio of standard deviation to the average, *COV*) gives a measure of the homogeneity of the concrete produced, i.e., a smaller *COV* implies a more uniform mixture. Table 2.1 shows the criteria and the values of *COV* requested. The *COV* does not depend on the type of concrete selected because it only depends on the relative variation of the parameters for a concrete. This method, proposed by RILEM, is the only attempt by any organization to standardize the process of measuring the efficiency of a concrete mixer.

2.5.3 Hybrid: Composition and Performance as Joint Indicators of Efficiency

The hybrid method to determine the efficiency of a mixer combines the methods described in Sections. 2.5.1 and 2.5.2. The only reference to a hybrid method was found in a paper by Peterson [12], which has been adopted in Sweden. The properties selected by Peterson are:

- distribution of cement content, fine aggregates and coarse aggregates in the mixer, measured as described in Section 2.5.2.;

• variations in compressive strength;

• variations in consistency as measured by the slump test with increased mixing time.

Table 2.1 RILEM efficiency criteria for concrete mixers [8]

Property	**Performance criteria**		
	Ordinary mixers (OM)	**Performance mixers (PM)**	**High performance mixers (HPM)**
W/F with $df < 0.25$ mm	$COV < 6\%$	$COV < 5\%$	$COV < 3\%$
F content with $df < 0.25$ mm	$COV < 6\%$	$COV < 5\%$	$COV < 3\%$
$D/2$ to D content	$COV < 20\%$	$COV < 15\%$	$COV < 10\%$
Air content		_ $M < 2\%$ $s < 1\%$	_$M < 1\%$ $s < 0.5\%$

F is the fine-element content (units are those of mass or mass/volume)

W is the water content (units are those of mass or mass/volume)

M is the maximum residual

df is the maximum size of the fine aggregates (mm)

D is the maximum size of coarse aggregates (mm)

s is the standard deviation.

As many parameters can affect the variations in concrete performance, the method adopted by Peterson was suggested to compare mixers using the same concrete. Peterson gives three types of concrete to select from (Table 2.2). These concretes were selected by him, and there were no fundamental studies to determine whether they are the optimum mixture composition for the purpose. He suggested that all three concretes be used with the mixer to be evaluated. Eight samples from each batch should be taken at various times during the concrete discharge, and the properties listed above measured.

A mixer can be considered adequate if the fractional variation between measurements on any of the above properties is less than 6 % to 8 % for each batch of concrete.

2.5.4 Output Rate as an Indicator of Efficiency

Another indicator of the efficiency of specified mixer is the output rate. The output rate is the amount of concrete produced per a time interval. The output rate is not a measure of the homogeneity of the concrete produced.

The output rate depends on the time needed to load the mixer, the mixing time, the discharge time, and the cleaning time, if it is a batch mixer. Very often this last stage is not considered, i.e., cleaning is not considered part of the mixing cycle. This omission is reasonable if the mixer is continuous or if it gets cleaned only once a day. Of course, for reasons of economics, the output rate should be high. However, it should be understood that it is dangerous to base the efficiency of a mixer solely on the output rate because there is no consideration of the quality of the concrete produced.

Table 2.2 Standard concretes [12]

Concrete types	Workability	Cement content (kg/m3)	Aggregate max diameter and grading curve
1	Slump[b] 100 mm to 150 mm	300	38 mm, curve 1[a]
2	Slump 20 mm to 50 mm	350	16 mm, curve 2[a]
3	Ve-Be[c] 10 s to 20 s	350	16 mm, curve 2[a]

[a] Curves 1 and 2 can be found in Ref. [12].

[b] The slump is measured according to ASTM C143 [5].

[c] The Ve-Be test is measured according to Ref. [13].

2.6 Mixing Energy

The mixing energy is defined as the product of the average power consumption during the whole mixing cycle and the duration of the mixing cycle. For reasons of economics, the mixing energy should be kept low but the quality of the concrete should be considered first. Johansson [14] varied the mixing time and measured the homogeneity of the concrete discharged by measuring the variation of the composition of the concrete produced (Section 2.5.2). He determined that a longer mixing time increased the homogeneity of the concrete discharged up to a point. The curve of aggregate distribution versus duration of mixing eventually reached a plateau, implying that any further mixing would not improve the homogeneity of the concrete produced. According to the measurements performed by Johansson [14], the time at which the plateau is reached depended strongly on the type of mixer and has some dependence on the maximum coarse aggregate size. Of course, shorter mixing times that still obtain an acceptable homogeneity for a given mixture are desired. This could determine the best mixer for the application, if the loading method is kept constant. Therefore, the optimum mixing time should be determined for each concrete mixture before starting a large production. The power consumption is often used to estimate the workability of the concrete. The theory behind this usage is based on principles of operation of a rheometer. A rheometer is an instrument that measures the stress generated by the material tested while applying a strain. In this case the strain is the constant speed of the blades and the stress is measured by the energy consumption. If it were possible to rotate the blades at different speeds and measure the power consumption at each speed, the mixer could be used to characterize the concrete's rheological behavior. Nevertheless, while the data obtained will not allow calculation of the rheological parameters of the concrete in fundamental units because the flow of concrete in a mixer is not linear and no equations are available for such a case, the measure of the energy consumption at one speed can be used to compare concretes prepared with the same mixer [15], or to monitor the workability of a concrete while it is mixed. For a given mixture composition, if the power consumption increases, it is an indication that the concrete workability is reduced. Therefore, the operator could determine the necessity of adding more water or HRWRA to obtain the workability desired. This methodology will avoid the necessity of discharging the mixer, measuring the workability using for instance a slump cone just to determine the amount of water, or determining the HRWRA dosage needed to obtain the desired workability.

Therefore, the mixing energy is a very useful tool to determine variation in the workability of the concrete being produced. However, there is no strong evidence that mixing energy can be used to determine the efficiency of a mixer, unless the only performance requirement is the workability.

2.7 Wear and Tear

In determining mixer efficiency, the main focus has been determining the homogeneity and the quality of the concrete produced. It was assumed that the mixer was operating as designed by its manufacturer. But long usage of a mixer leads to wear of the blades and/or scraper, or the build-up of materials (hardened mortar or cement paste) on the blades, the container, and/or the scraper. Wear and build-up will change the geometry of the mixer and therefore the flow pattern of the concrete, and may lead to changes in the concrete produced [16]. To avoid this situation, the concrete mixer should be thoroughly cleaned at the end of each day of operation and the blades and/or scraper changed on a regular schedule.

It can be argued that criteria for a mixer selection should include

- ease of cleaning;
- cost and difficulty of replacing the blades or parts;
- sensitivity of the mixer to wear and tear of the blades.

Therefore, to summarize what is stated in the literature, the existing concrete mixer machines have some short comings in the following areas.

- Micro enterprises and TVET institution are not engaged in producing concrete mixing machine.
- Portable concrete mixers may be powered by a gasoline engine, although it is more common that they are powered by electric motors using standard mains current and if there is interruption of electric power, the operation become stopped.
- The older mixers are heavy and cannot be moved as easily. They are still self powered with an electric motor.

But our design is based on the consideration of avoiding as much all the above mentioned problems. So that, the above literatures we organized are helpful in finding the science of production of concrete mixing machine.

CHAPTER THREE
MATERIALS AND METHODOLOGY

3.1 Introduction

This chapter presents the research methodology employed to achieve the thesis objective including instrument development, sample selection, data collection and data analysis.

3.2 Instrument development

In this study, exploratory research method is used to identify key issues and key variables. Exploratory research might involve a literature search or conducting focus group interviews. The exploration of new phenomena can help our need for better understanding and test the feasibility of a more extensive study, or determine the best methods to be used in a subsequent study. For these reasons, exploratory research is broad in focus and provides definite answers to specific research issues.

3.3 Sample selection

Sampling involves selecting relatively small number of elements from the large defined group of elements and expecting that the information gathered from small group allow generalization to be made about the larger group of population. (Research method for construction 3rd edition)

The sampling units are the defined target population elements available for selection during the sampling process. In this research, three of Adama Town construction site workers are selected purposely as the total population from Afrotsion construction PLC, Tekleberhan Ambaye construction PLC, and Small and Micro enterprise construction site contractors since the result can be considered for the whole building construction site workers in the country.

A total of 15(5 from SME, 3 from Tekleberhan Ambaye and 7 from Afrotsion) numbers of concrete mixing workers are randomly selected from the population of 30 from the three sites. The reason why only Adama Town is selected for this study is, the town is near to Adama Science and Technology University(ASTU) and due to limited budget and time constraint as well; the researchers couldn't include other places from the country. The sampling is selected by using random sampling method. The sample ratio can give sufficient information because it is taken 50% out of total population.

3.4 Data Collection

Three data gathering techniques have been used to understand current situation of concrete mixing machine through questionnaire, interview and observation. Data are collected by questionnaires (closed and open ended questionnaires), interviewing and direct observation. The documents which are analyzed for the project are internet, and many types of reports and researches about concrete mixing machine. After the quantitative and qualitative (mixed approach) data are gathered from those sources, concrete mixing machine is designed and manufactured as a solution for those problems underlined from the respondents response to facilitate concrete products and to avoid exhausting and time consuming of concrete mixing processes.

The reason why we used mixed approach is because: *A mixed methods research design is a procedure for collecting, analyzing, and "mixing" both quantitative and qualitative research methods in a single study to understand a research problem.*

The other reason (Rationale for the Design) could be;

- successfully explain social events & relationships in their full complexity,
- better understand the context and reality in breadth & depth,
- obtain a variety of information on the same issue,
- use the strength of each of the qualitative & quantitative approaches to overcome the deficiencies of the other, &
- achieve a higher degree of validity and reliability (Schulze, 2003;Sarantakos ,1998)

3. 4.1 Survey questionnaire

Survey questionnaire is designed and distributed for assessing concrete mixing machine in selected areas. Twelve questionnaires were distributed and collected all in all from the randomly selected users. The composition of the persons who were participated in the response of the questionnaire includes:

Concrete mixing workers, concrete users, technical workers, and others who work in related area.

The objectives of the questionnaire are:

- To identify the problems related with concrete production for building and construction workers.
- To assess attitudes and tendency towards concrete mixing machine
- To know how effectively is the concrete mixing machine is used in the construction site.
- To compare the existing mixing operation with two ways (electrical and manual) concrete mixing machine.

The survey questionnaire contains about fifteen questions requiring two types of answers.

a. The first type uses options from the alternatives (objective)

b. Subjective type questions, which need brief answer.

3.4.2 Interview

The interview included from different private sectors and customers specially small and micro enterprise. Structured interviews (face to face) were conducted with different concrete mixing workers and concrete product users. Most of the interview questions conducted is similar to the questions in the questionnaire. This helped us to crosscheck the response given by the respondents on both methods of assessment.

Objectives of conducting the interviews:

- To investigate feeling of the people who use the existing concrete mixing machine in Adama town.
- To observe overall activities and processes in the respective areas of concrete

producers for construction.

- To assess the existing system of concrete mixing method and identify the drawbacks.
- To assess the need of users and gathering data that are related with how to make some changes to the existing concrete mixing system.

3.3.3 Direct observation

We have also used this method for better understanding of the existing machine and to compare data gathered from questionnaire and interview. And based on this we systematically adjusted and interpreted gathered data and documents.

3.5 Data Analysis and Interpretation

Data collected through questionnaires, interviews, direct observation and documents are analyzed & interpreted. It is believed that the current situation of the concrete mixing methods has exactly reflected the problems in these questionnaires and interviews. This analysis is important to get wide and in depth information from the respondents.

According to the respondents response, 15(100%) replied as they did not purchase any concrete mixing machine. 13(86.67%) of the respondents replied as there is a need of concrete mixing machine is available in the market while 2(13.33%) replied no need. 14(93.3%) of the respondents responded “yes” for the item whether they are interested or not to buy concrete mixing machines can be made at Adama Science and Technology University with reasonable price while 1(6.7%) replied “no”. From this point of view it can be concluded that one of the main factor not to have the machine easily is its price. 15(100%) of the respondents replied the machines they are using is only electrically operated. Therefore, the design consideration of this project will meet the need of the market. 4(26.67%) of the respondents replied as there are different types of concrete mixers in the market while the rest 11(73.33%) do not know whether there is or no. All of the respondents did not work with the manually operated mixing machine. According to the respondents, 5(33.33%) of them responded that the machines can be easily maintainable while the rest 10(66.67%) replied not easily maintainable. This shows that there is a gap to train how the machines can be maintained. Some 2(12.33%) of the respondents know as there is different types of mixers while 13(86.67%) do not. On the other hand all, 15(100%), of the respondents responded that as there is no spare parts or the machines come without spare parts. 3(20%) of the response for the possibility of moving machines from place to place is positive while 12(80%) of them faced difficulty of moving the machine. This shows that the users are working with the oldest machines.

According to the respondents' response in open question types, all the machines are made in abroad and they prefer if there is a possibility of operating the machines manually. On the other hand maintenance activity of the machine is controlled by some other professional outside of the construction site. There were also problems related to concrete mixing machine and some of them are:

- Difficulty of moving from place to place by pushing or carrying.
- Interruption of electric power stops the machine not to mix until the power comes again.
- Unavailability of the machine as needed
- Extra cost and time wasting during searching for the machine. The cost includes renting cost of the machine; for example 3,000(three thousand birr) per day.

To sum up, the response from the interviewee also indicated that if concrete mixing machine with different operational functions are designed, the concrete processing time will not be interrupted. On the other hand they assured that most mixer machines were brought from abroad and at moment Kality spare part PLC and Defense engineering were manufacturing the machine with the direct copy of abroad meaning they did not changed to country's capability of producing everywhere like TVET and Small scale microenterprises.

CHAPTER FOUR

DESIGN ANALYSIS AND MATERIAL SELECTION

4.1 Introduction

This chapter introduces the design analysis and material selection of critical components for manual and electrical concrete mixing machine on the problems identified with a view to evaluate the necessary design parameters, strength and size of materials for consideration in the selection of the various machine parts.

Design

From the study of existing ideas, a new idea has to be conceived. The idea is then studied keeping in mind its commercial success and given shape and form in the form of drawings. In the preparation of these drawings, care must be taken of the availability of resources about money, men and materials required for the successful completion of the new idea into an actual reality. In designing a machine component, it is necessary to have a good knowledge of many subjects such as Mathematics, Engineering Mechanics, Strength of Materials, Theory of Machines, Workshop Processes and Engineering Drawing.

General Considerations in Design

- Type of load and stresses caused by the load;
- Motion of the parts or kinematics of the machine;
- Selection of materials;
- Form and size of the parts;
- Ergonomic consideration; and
- Use of standard parts and safety operations; etc.

This designs of manual and electrical concrete mixer machine focus on two functions that are manual mixing and electrical mixing process. Starting from the idea of design principles and functional requirements, the researchers designed the parts of the machine based on the design procedures.

Redesigned Machine description

The mixing process is done by the impact of a cylindrical drum equipped with a number of blade mounted on its sideline attached to the central shaft. Its operation is achieved by rotational motion of a cylinder fitted with beater peg inside the drum and its stationary grid (twist) which results in the process of shake (stir) the grain inside the drum during the mixing process of concrete. The mini concrete mixing machine was redesigned to be made from the following major parts.

I. Mixing blade: is a device that homogeneously mix cement, aggregate such as sand or gravel, and water to form concrete, by means of a revolving drum. It is the part where the grains are beaten and remix the component of an aggregate simultaneously in the barrel to make concrete. It is made from HSS, that has 2 blades attached with inside of the revolving drum of the machine with a wing length of 250mm from the central shaft. It consists of a rotary drum with beater pegs and a stationary concave grid, normally in axial flow thresher.

II. Mixing drum: It is the standard part made of mild steel material and it is attached with a shaft and u-channel from motor side with external diameter of 580mm and length of 810mm. It is used as a container to mix aggregate, cement sand and water for the production of concrete. And also 480mm length u-channel is welded on drum base as reinforcement.

    U- Channel is firmly welded to the base of a drum to fix shaft end by bolt together. The function of this u-channel is to provide strength to the drum base because drum base cannot alone with-stand the twisting load of the shaft.

    U-channel of 70, 80 and 560mm of internal, external and length respectively with T- shape are attached with the base of the drum by shielded metal arc welding.

Technical specifications of the machine

Table 4.1 Part names and specifications

Part name	Specification
Drum	Mild steel (Diameter .480mm,length 885mm)
Blade	length 400 depth of filet radius 210mm chord length 633mm, clearance between blades are at 120^0
Frame	50x50x1.5mm
Dc motor	2.5KW
Bearing	P206
Shaft	Diameter 35mm
Pulley	Internal diameter 35mm and external 350mm
Belt	V-belt
Bolt	M17 and M10
Key	10x8

4.2 Material selection, processes and its factors

Material selection is a step in the process of designing any physical object. In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of applicant materials. The selection of materials and the processes used in fabrication are integral parts of the design of a machine component.

The characteristics that are usually considered when selecting a material for a given application can be classified into the following categories:-

1. Mechanical behavior including shear strength, yield strength, tensile strength, elongation percent, reduction in area percent, hardness, toughness, fatigue strength and stiffness resistance to abrasion and erosion are also related to mechanical behavior;
2. Chemical properties which include corrosion and oxidation resistance;

3. Physical characteristics including electrical, magnetic and thermal properties. Density is also included in this category;
4. Process ability which includes castability, workability, weldability and machinability.

In selecting materials for a given application it is useful to classify them according to the major function they are expected to perform in service.

One of the most difficult problems for the designer is improper materials selection for engineering purpose. The best material is one which services the desired objectives of material selection is at the minimum cost and the required purpose must be followed.

So that, we considered the flowing factors while selecting material.

- Availability of the material in the form and shape desired;
- Total cost of the material including initial and future cost;
- Material properties as they relate to service performance requirements;
- Suitability of material for working condition in service;
- Substitutability of the materials; and
- The processing of the material into a finished part.

Generally material selection factors are service performance (specifications), availability, economics (total cost), material properties, manufacturing processes, formability and join ability and finishing and coatings.

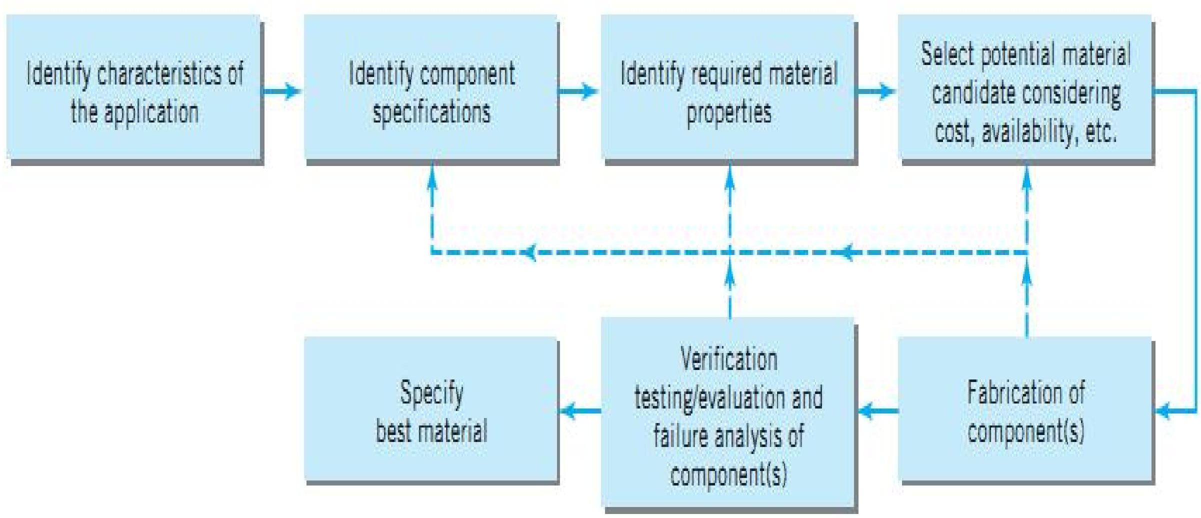


Figure 4.1 Material selection processes for a machine parts [Automation,

Production system and Computer Integrated Manufacturing, 2nd edition]

4.2.1 Material selection for significant parts/components

Selecting the right material for the machine can fulfill the functional requirement of the specific part. We followed the digital logic methods to select the suitable material.

The steps for digital logic methods are:-

- Set the functional requirements for the part under consideration. This are used to set rating factor;
- Rank the rating factors (properties) then determine the weight factors;
- Total number of decision/**N/=** $\frac{n(n-1)}{2}$ Where n is the number of rating factors/properties/;
- Write the most suitable candidate materials and enlist properties from standard data table /the data quantitative or qualitative/ ;
- Normalize the outcomes of the parts;
- Value outcomes and overall satisfaction of parts. The overall satisfaction shall at last ranked, and the rank shows the result on the basis of the allocated weight factors which gives the best overall satisfaction for the functional requirements of the part.

4.2.1.1 Material selection for Shafts

In order to minimize deflections, medium carbon steel is the logical choice for a shaft material because of its high modulus of elasticity, though cast or nodular iron is sometimes also used, especially if gear or other attachments are integrally cast with the shaft. Most machine shafts are made from low-to- medium carbon steel, either cold rolled or hot rolled, though alloy steels are also used where their higher strength are needed. Cold-rolled steel is more often used for small-diameter shaft(less than about 3-inch in diameter) and hot-rolled used for large size. (Textbook of machine element Shigley 8th ed.)

Functional requirement for Shaft

The main function of shaft is to transmit power. Since the shaft is subjected to high torque, it may be bent, so the shaft should have properties that to resist bending moment and torsion.

Material requirement for shaft

To achieve the required functional requirement of the above mentioned materials, there should be the following properties:-

- ✓ Yield strength and tensile strength
- ✓ Wear resistance
- ✓ Corrosion resistance
- ✓ Modulus of elasticity

Therefore, number of decision $(N) = \frac{n(n-1)}{2} = \frac{5(5-1)}{2} = 10$

....(Material selection in mechanical design)

where n= no. of properties to be evaluated so digital logic with different decision, material requirement with its weight factor and normalized value, performance index, figure of merit etc. of shaft is shown below.

$$\textbf{Weight factor (Wf)} = \frac{positive\ decision}{total\ No.\ decision} = \frac{1+1+0+1}{10} = 0.3$$

Table 4.2 Application of digital logic with different decisions number.

Properties	**Number of Decision**										**Weight factor**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
yield strength	1	0	1	1							0.3
tensile strength	0				1	0	1				0.2
wear resistance		1			0			0			0.1
corrosion resistance			0			1		1		0	0.2
Elasticity				0			0		1	1	0.2

Table 4.3 Applicant material requirements for shaft

No	Materials	yield strength	tensile strength	wear resistance	corrosion resistance	modulus of elasticity
1	AISI NO.1010 hot- rolled	179	324	3	4	12
2	AISI No.1020 hot- rolled	207	379	4	3	12
3	ASTM No.A570-A	170	310	2	1	13
4	ASTM No. A675 Grade-45	155	380	3	2	13

Table 4.4 Normalized value of shaft

No.	Material	yield strength	tensile strength	wear resistance	corrosion resistance	modulus of elasticity
1	SAE/AISI NO.1010 hot- rolled	86.5	85.3	75	100	92.3
2	SAE/AISI No.1020 hot-rolled	100	99.7	100	75	92.3
3	ASTM No.A570-A	82.13	81.6	50	25	100
4	ASTM No. A675 Grade-45	74.9	100	75	50	100

<u>Note</u>: - During normalizing numbers 100 is given the maximum number for higher functional requirement of material and for the remaining number used in cross multiplication to obtain similar results, but for lower requirements of material (for example specific gravity) 100 gives to the smallest no. & for the rest no. use the smaller no. multiplying by 100 divided the no. to obtain the required result.

Performance index (μ) = Σ(normalized value) (weight factor)

Table 4.5 Shows performance index (value out comes)

No.	Material	Yield strength x 0.3	Tensile strength x 0.2	Wear resistance x 0.1	Corrosion resistance x 0.2	Modulus of elasticity x 0.2	Perfor mance index	Rank
1	SAE/AISI NO.1010 hot- rolled	25.95	17.06	7.5	20	18.46	88.97	**2**
2	SAE/AISI No.1020 hot- rolled	30	19.94	10	15	18.46	93.4	**1**
3	ASTM No.A570-A	24.64	16.32	5	5	20	70.96	**4**
4	ASTM No. A675 Grade-45	22.47	20	7.5	10	20	79.97	**3**

From the above result of material selection shows that **<u>AISI No.1020 hot rolled</u>** is the material for the shafts so mostly shafts are made of low -to-medium carbon steel one of these materials is ***<u>mild-steel</u>***.

4.2.1.2 Material selection for large Pulley

Functional requirement for pulley

The main function of pulley is to transmit power from the prime mover to the driven shaft through belt.

Material requirement for pulley

- ✓ The material should possess optimal tensile strength;
- ✓ The material should have adequate value of yield strength;
- ✓ Density of the material should meet value of safe operation ;
- ✓ It possesses moderate specific heat capacity;

- ✓ Coefficient of linear expansion of the material should lie at range of minimal value;
- ✓ Wear resistance.

Total number of decision/N/ = $\frac{n(n-1)}{2}$ Where n=5 ; N = $\frac{5(5-1)}{2}$= 10

Table 4.6 Weighting factors for pulley

Properties	**Number of Decision**										**Weight factor**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Tensile strength	0			0		1		1			**2/10 = 0.2**
Yield strength		0			0				0	1	**1/10 = 0.1**
Density	1	1	1				0				**3/10 = 0.3**
Specific heat capacity			0		1	0		0			**1/10 = 0.1**
Coefficient of linear expansion				1			1		1	0	**3/10 = 0.3**

Table 4.7 Properties of candidate materials for pulley

Materials	**Tensile strength**	**Yield strength**	**Density**	**Specific heat capacity**	**Coefficient of linear expansion**
AISI1010	370	300	7.85	0.47	12.20
AISI1035	550	460	7.85	0.48	11.50
ASTM 20	152	152	7.20	0.34	11.00
ASTM 25	197	197	7.35	0.46	10.00

Table 4.8 Normalized outcomes for pulley

Materials	**Tensile strength**	**Yield strength**	**Density**	**Specific heat capacity**	**Coefficient of linear expansion**
AISI1010	67	65	100	72	82
AISI1035	100	100	100	71	87
ASTM 20	27	33	92	100	91
ASTM 25	32	39	95	74	100

Table 4.9 Shows performance index (value out comes)

Materials	**Tensile strength x 0.2**	**Yield strength X0.1**	**Density x0.3**	**Specific heat capacity x 0.2**	**Coefficient of linear expansion X 0.3**	**Performance Index**	**Rank**
AISI1010	13.45	6.5	30	7.2	24.6	81.75	2
AISI1035	20	10	30	7.1	26.1	93.20	1
ASTM 20	5.4	3.3	27.6	10	27.3	73.6	4
ASTM 25	6.4	3.9	28.5	7.4	30	76.2	3

Therefore, from the above candidate materials **AISI1035** is a best suitable for the pulley material which is relatively less weight.

Table 4.10 Application of digital logic with different decisions numbers

No.	Properties	Decision number															Wf
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	Yield strength	1	1	0	0	0											0.13
2	Tensile strength	0					1	0	0	0							0.07
3	Young's modulus		0				0				1	1	0				0.13
4	Fatigue strength			1				1			0			1	1		0.27
5	Density				1				1			0		0		0	0.13
6	Corrosion resistance					1				1			1		0	1	0.27

4.2.1.3 Material selection for bearing house

Function requirement

Since the bearing is inserted into the bearing house for supporting the shaft and facilitate its motion the bearing housing should have a property that resist the bearing stress and also it resist the torsion of the shaft due to rotational motion. The machinability of the part should be considered to have a shape of bearing.

Material Requirement

To satisfy the functional requirement for selecting bearing house, the material should have:-

- better yield strength-better tensile strength
- higher young's modulus of elasticity-high corrosion resistance
- it should be tough enough-it should be machine able
- it should be light in weight

4.2.1.4 Material selection for bearing

Functional requirement

A bearing is a machine element which supports other moving machine components (known as Journal, i.e., the portion of the shaft resting on the sleeve). It permits a relative and smooth motion between the contact surfaces of the members, while carrying the load.

Since there is a relative motion between the bearing and the moving element, a certain amount of power must be absorbed in overcoming friction, and if the surface actually touches, there will be a rapid wear.

Material Requirement

The various considerations in the selection of bearings to satisfy the functional requirement, the bearing should have:

- Direction of load relative to bearing axis;

- Intensity of loads. Ball bearings can sustain considerable loads;
- Speed of rotation;
- Thermal stability;
- Shaft stiffness. Rigid bearings are used for stiff well designed shafts;
- Class of accuracy of the machine.

Table 4.11 Shows bearing standards (fundamentals of machine component design)

Bearing Basic Number	**Bore(mm)**	**OD (mm)**	**W(mm)**
L05	25	47	12
205	25	52	15
305	25	62	17
L06	**30**	**55**	**13**

Already, we have designed shaft diameter of **35mm**. therefore based on the diameter of shaft and the properties of bearing mentioned above, ball bearing with Bearing Basic Number **L06**, from the above table is selected for this project.

4.3 Design of Critical Components

The main parts of our project includes Motor, Pulleys, shaft, mixing blade, Key, Bolt, drum and stand etc.

Design of Shaft

The torsion equation may now be written as

$\frac{T}{\frac{\pi}{32}d4} = \frac{\tau}{d/2}$ or $T = \frac{\pi}{16}\tau d^3$ $\Longrightarrow$ $d=\sqrt[3]{\frac{16x170609.451}{\pi x50}} = 25.90mm$ we modified the shaft diameters to 25-38 that is recommended from standard table (text book of machine design)

The length

$$\theta = TL/JG \text{ .... Eq(1)}$$

Where T= twisting moment of shaft

L= length of shaft

J= polar momentum of shaft material

G= 0.8x10^5 mpa

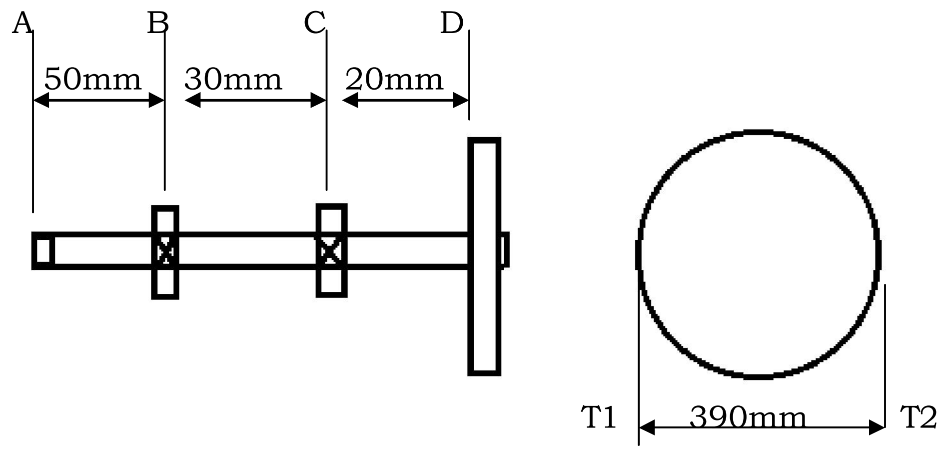


Figure 4.1 shaft Assembly with pulley & bearing

$J=\frac{\pi}{32}d^4$ ……………………………………eq(2)

$J=\frac{\pi}{32}\ x30^4$ =79481.25mpa

$\theta=\frac{TL}{JG}0.01=\frac{264937.5L}{79481.25x0.8x105}$ L= 240mm

Therefore the shaft length adopted from the standard table 200 -450mm is advisable from the standard table machine design page 443

4.3.1 Design of Driver Shaft

This shaft is a rotating solid part which is used to transmit power from the electric motor through belt and pulleys to the driven shaft through pulley by means of key. The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) set up wit in the shaft permits the power to be transmitted to the driven shaft. The required torque to transmit power to the driver shaft is obtained by using the following relation.

We know that power transmitted (in watts) by the shaft,

$P = \frac{T}{\omega}$, $\omega = \frac{60}{2\Pi n}$ so, $T = \frac{Px60}{2\Pi n}$ Where T- is twisting moment in N-m

n - is speed of shaft in RPM = 1400 RPM

P-is power required = 2.5 Kw = **<u>17183.8 N-m</u>**

$$T = \frac{\tau\pi d^3}{2\pi d} \text{.................................eq(3)}$$

$$T = \frac{2.5x1000wx60}{2\pi x1400}$$

Where

τ = the shar stress of shaft

d=diameter of the shaft

T= is torque transmitted by shaft

$\tau = \frac{Sys}{Fs}$ *Where* Sys =yield stress of shaft 400 c8 taken from machine design table below

Fs = factor of safety

$$\tau = \frac{Sys}{Fs} = \frac{380mpa}{3.5} = 54.34mpa$$

The members like pulleys, bearing house, mounted on the shaft are exerted forces which cause the shaft to bending and twisting.

The material to be selected for the manufacturing of shaft for the project should meet the following criteria. The desirable properties of the materials for the designed shaft should be;

- Sufficient in strength-Machine able
- Impact resistance- Tough and resist fatigue
- Heat resistance
- Good heat treatment
- Wear resistance

Mechanical properties of steels used for shafts (Text book of Machine design)

Table 4.12 Mechanical properties of steels used for shafts

Indian Standard Designation	Ultimate tensile strength in MPa	Yield strength in MPa	Remark
40C8	560-670	200-380	Used for shafts, gears stud bolts, spindle, washer etc. for light stressed
45C8	610-700	220-350	Used for lead screws, feed rods bigger gears, bigger shafted…
50C4	640-760	370	
5012	700 minimum	390	

From this mechanical properties of steels used for shafts, we choose **40C8** material because our project is derived with simple mechanism by considering its yield strength of **380 MPa**.

Because the ordinary transmission shaft are made of medium carbon steel with a carbon content from 0.15 % to 0.40% such as 30 C8 or 40 C8 these steel are commonly called machinery steel where the greater strength is required high carbon steel such as 45C8 or 50C8 are employed.

Stresses on the shafts

The stresses induced in the shaft are:

- Shear stress due to transmission of torque (i.e. due to torsional load)
- Bending stress (compression) due to forces acting up on the shaft
- Stress due to combined torsional and bending loads.

Maximum permissible working stress for transmission shafts

According ASME code for commercial steel shafts, the maximum permissible shear stress is taken as 40-42 MPa for shafts with key and 55-56 MPa for shafts without key.

For shafts purchased under definite physical specification, the permissible shear stress (allowable shear stress) is 25 % of yield strength but not over 18% of ultimate strength in tension for shafts with key ways.

$\tau=0.75\sigma_y$ or $\tau=0.18\sigma_u$ Where τ - is permissible shear stress

σ_y -is yield strength

σ_u -is ultimate tensile strength

For this design the permissible stress is $\tau=0.5\sigma_y$ = 0.5x380 MPa = <u>190 MPa</u>

$\tau=0.75\sigma_y$ because it is keyway on the shaft so shear stress is maximum

$\tau_{max} = 0.75\sigma_y$ = 0.75x380mpa =285mpa

In designing shafts on the bases of strength, the following cases may be considered.

i. Shafts subjected to twisting moment or torque only

When the shaft is subjected to twisting moment (torque) only, then the diameter of the shaft may be obtained by using the torsion equation.

$\frac{T}{J} = \frac{\tau}{r}$ Where, T- is twisting moment acting up on the shaft

J- is polar moment of inertia of the shaft about the axis of rotation

τ - is torsional shear stress and r- is radius of the shaft = d/2

For round solid shafts polar moment of inertia,

$$J = \frac{\Pi}{32}d^4 \text{........ ....eq(4)}$$

The torsion equation may now be written as

$$d= \sqrt[3]{\frac{16T}{\pi\tau}} \text{....... .... eq(5)}$$

$\frac{T}{\frac{\Pi}{32}d4} = \frac{\tau}{d/2}$ or $T = \frac{\Pi}{16}\tau d^3$

$P = \frac{T}{\omega}, = \frac{60}{2\Pi n} = \frac{2.5KW\ x180}{1400\ x3.14} = 17183.8Nmm$

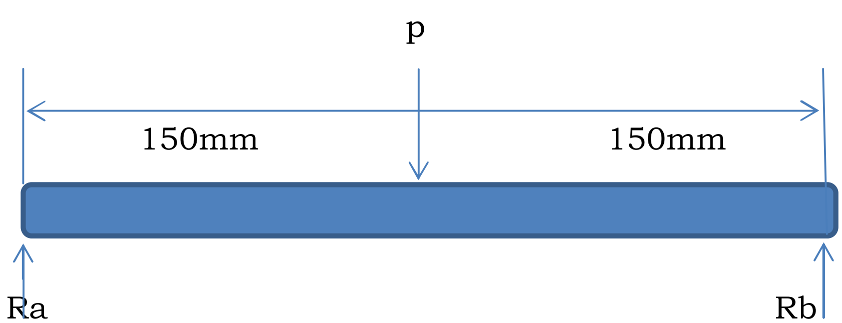


Figure 4.2 Twisting moment or torque of shaft

The tangential force due to the torque of pulley becomes

$$Ft = \frac{T}{Rp} = \frac{17183.8Nmm}{50} = 343.63N$$

Shear force and bending moment

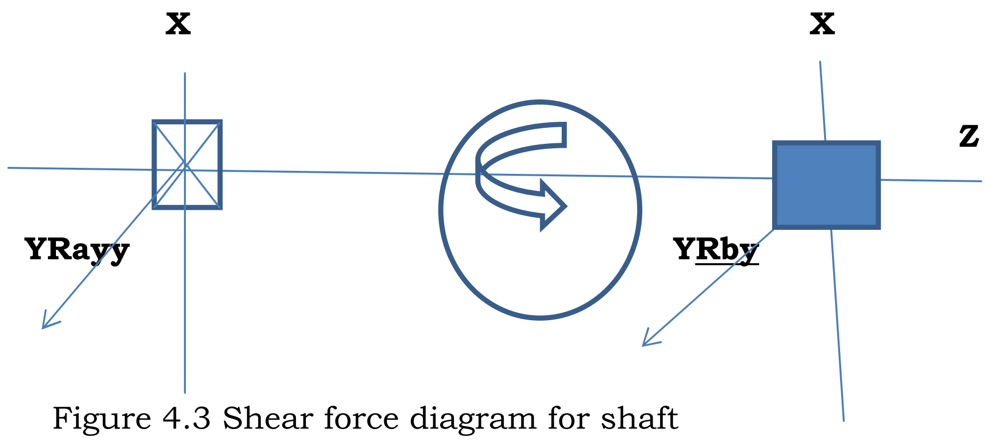


Figure 4.3 Shear force diagram for shaft

Radial force (Fr) in40^0 grooving of the pulley is

Fr= Fttan =343.68Nmm xtan40^0 =288.838Nmm

Reaction force at the bearing point

$$Ray = \frac{Ft}{2} = Rby = \frac{343.68}{2} = 171.84N$$

$$Rax = \frac{Fr}{2} = \frac{288.38}{2} = 144.19N$$

Therefore reaction force Ra and Rb becomes

$$Ra + Rb = \sqrt{\frac{Rax^2}{Rby^2}} + \sqrt{\frac{171.84^2}{144.19^2}} = 224.32$$

Resultant force (F) is

$$W = \quad Ft \quad = \frac{Ft}{cos\theta} = \frac{343.68}{cos400} = 448.64N$$

The shear load and bending moment acting on the shaft can be obtained as

B.M at Z=0

$$VX = Rax = \frac{Fr}{2} = \frac{288.38}{2} = 144.19N$$

B.M at Z=200mm

VX= Rax –Fr

VX =144.19-288.38 =-144.19N

B.M at Z=300mm

VX= Rax –Fr +Rbx

VX =144.19-288.38+144.19 =0

Vx= 144.19N

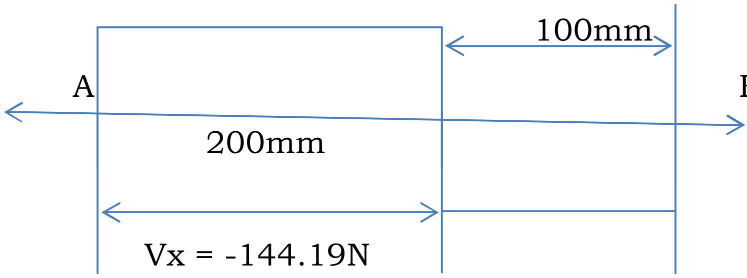


Figure 4.4 Bending moment acting on the shaft

Reaction force @ zy plane

B,M at Z = 0

B.M @ Vy =Ray= $=\frac{Ft}{2}=\frac{113.68}{2}$

Vy = 56.84 N

B.M @ y =200mm

Vy =Rby – Ft

Vy = 56.84 - 113.68

Vy =- -56.84 N

B.m@ Z=300mm

Vy = Ray –Ft+Rby

Vy = 56.84 -113.68 +56.84 Vy = 0

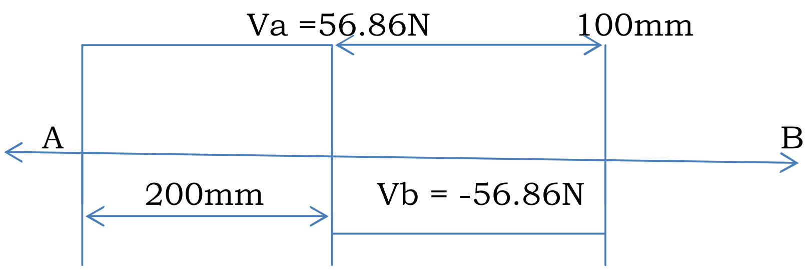


Figure 4.5 Bending moment acting on the shaft @ xz plane

shear force of magnitude XZ plane

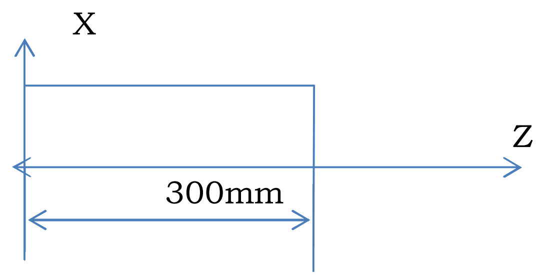


Figure 4.6 Shear force of magnitude XZ plane

The bending moment of @ xy plane is

B.m @z =0

Mx =Rax(Z-0) =Rx(0-0)

B.m @ z = 200mm

Mx = Rax(200-0)-Fr(0-0)

Mx =28838N

B.M @z= 300

Mx = Rax(200-0)-Fr(z-200mm) +Rax(z-300)

Mx =144.19(300-0) -288.38(300-200) +144.19(300-300)=0

B.m @Z =275mm

Mx = Rax (Z-0) –Fr(Z-65mm)

Mx = 144.19(275mm)-288.38(275.38-200)

Mx =39625.25- 21628.5

Mx =18023.75N.mm

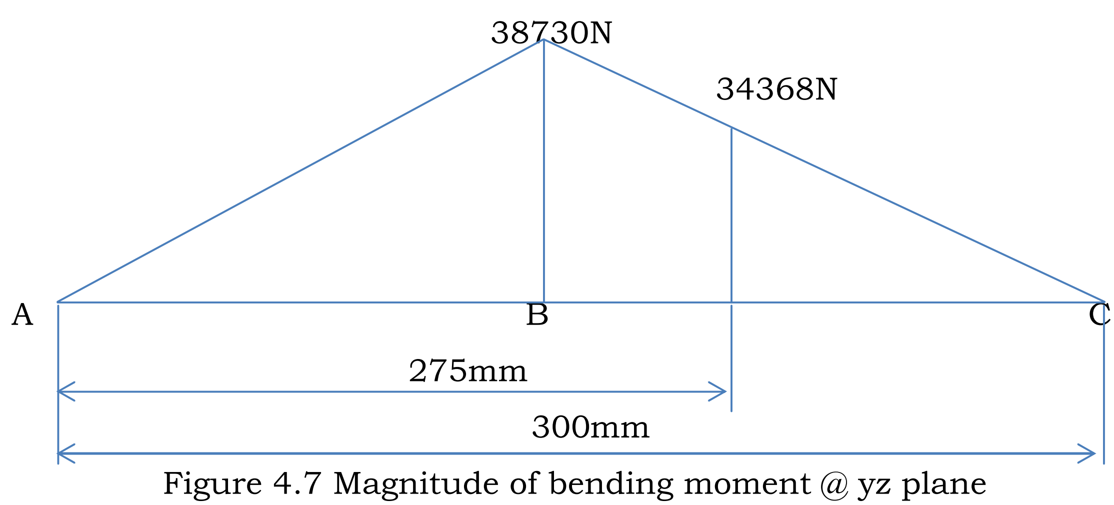


Figure 4.7 Magnitude of bending moment @ yz plane

Bending Moment of YZ Plane

B.M @ Z= 0

My =Ray(Z-0)

B.M @ Z=200mm

My = Ray (Z-0) Ft(Z-0)

My= 171.84(200-0) -343.68(200-200)

My = 34368N.mm

B.M @Z =300mm

My =Ray(Z-0)- Ft(Z-200) +Rby(z-300mm)=0

B.m @ z=275mm

My = Ray (z-0)- Ft(Z-200)

My = 171.84(275-0) -113.68(275-200)

My= 47256-1136.75

My =38734N.mm

Magnitude of bending moment

$M^2 = Mx^2 + My^2$ ....eq(6)

$= 28838^2 + 34368^2$

=44864.1245N.mm

Magnitude of at Z =275mm

B.M @ Z=275mm

$$M = \sqrt{MX^2 + MY^2} = \sqrt{18023.75^2 + 34368^2} = 34416.35 \text{ N.}$$

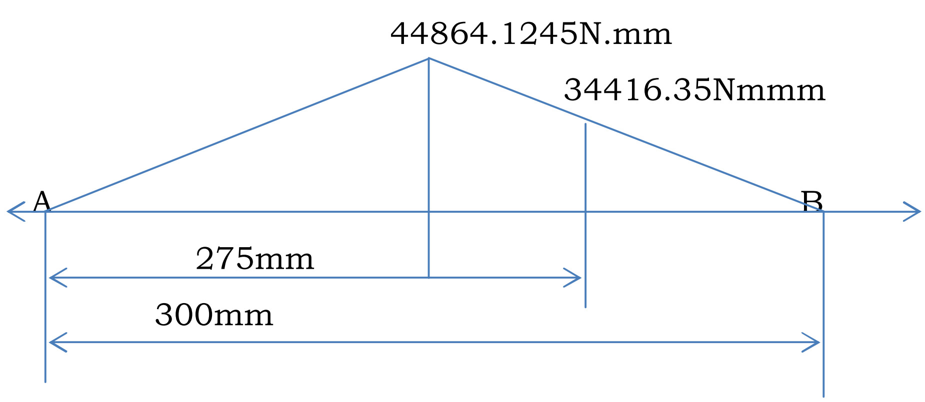


Figure 4.8 Magnitude of bending moment

Design of shear stress of shaft

The torsion equation may now be written as

$\frac{T}{\frac{\Pi}{32}d4} = \frac{\tau}{d/2}$ or $T = \frac{\Pi}{16}\tau d^3$

$T = \frac{\Pi}{16}\tau d^3$ 170609.45= $= \frac{\Pi}{16}\tau 35^3$ = 20.28N.mm

So 54.34mpa>20.28 mpa The design is safe

Deflection of shaft

Since the shaft is considered as simple beam concentrated load (P) a center

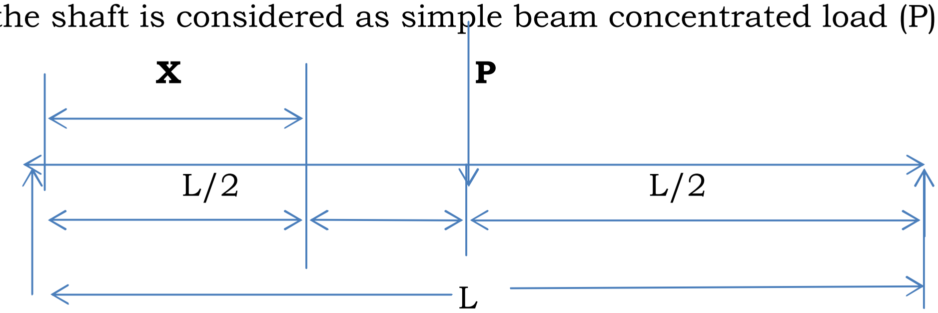


Figure 4.9 Deflection of the shaft

$Y_{max} = \frac{PxL^3}{48xExI}$ where Ymax = maximum shear stress of the shaft

P= load of the shaft

E = the elongation of the shaft for steel is $209.55x10^2$mpa

I = momentum of inertia the solid shaft

L = length of the shaft

$I = \pi d^4 / 64$ ----------------------------eq(7)

$I = \pi 35^4 / 64$ =736244.4N.mm

Max =44864.1245N.mm

So $Y_{max} = \frac{PxL^3}{48xExI} = \frac{419.67x300^3}{48x209.55x105x39746.62}$ $=0.0283x10^6$ mm

Yx (when x<L/2) = $\frac{Px(3L^2}{48xExI} - 3x^2$

Since L/2 =300/2 =150mm

Let take X= 150/2 45 mm

$Y_{max} = \{(419.67x150)(3x(300^2 -4(150^2)\}$

Y_{max}= 0.01133mm

The transition shaft

Shafts subjected to combined twisting moment(T) and bending moment(M)

When the shaft is subjected to combined twisting moment and bending moment, the shaft must be designed on the bases of the two moments simultaneously. Two types of theories have been subjected to account for the elastic failure of the shaft when it is subjected two various combined stresses. The two types of theories are:

a. **Maximum shear stress theories**: used for this design because it is used for ductile materials such as mild steel

b. **Maximum normal stress theory**: used for brittle material such as Cast iron.

According to Maximum shear stress theory, the maximum shear stress in the shaft is given by $\tau_{max} = \frac{1}{2}\sqrt{\sigma_b{}^2 + 4\tau^2}$

Substituting the values of τ and σ_b from torsion equation and bending equation, we have

$$\tau_{max} = \frac{1}{2}\sqrt{\left(\frac{32M}{\Pi d3}\right)2 + 4\left(\frac{16T}{\Pi d3}\right)2}\sqrt{M2 + T}^2$$

$$\tau_{max} = \frac{\Pi}{16}\tau_{max}\, d^3 \text{.............................eq(8)}$$

The expression $\sqrt{M2 + T}^2$ is known as equivalent twisting moment and is denoted by T_e.

The equivalent twisting moment Te may be defined as the twisting moment, which when acting alone produces the same shear stress (τ) as the actual twisting moment. By limiting the maximum shear stress (τ_{max}) equals to the allowable shear stress (τ) for the shaft material equation4.8 can be written as:

$$T_e = \frac{\Pi}{16}\tau d^3 \text{..................................eq(9)}$$

I. Maximum principle stress. Since the shaft is subjected to bending and torsion moment at any axial force.

$$x \;=b =\frac{32Mb}{\pi d^3} \text{ ....eq(9a)}$$

$$bm =\frac{16Mt}{\pi d^3} \text{ ....eq(9b)}$$

By substituting the equation

$$bm_1 =\frac{16}{\pi d^3}\left[Mb+\sqrt{mb^2+mt^2}\right] \text{......... ..eq(10)}$$

$$Ft = \frac{2Tp}{d\;(largepulley)} = \frac{2\,x1705.23}{300} = 34.10\text{Nmm for large pulley}$$

Maximum bending of on the pulley for shaft

$$Mb = \frac{WL}{4} = \frac{200Kg\;x300mm}{4} = 15000\text{N. mm}$$

$$\delta\,1 =\frac{16}{\pi d^3}\left[Mb+\sqrt{mb^2+mt^2}\right]$$

$$\delta\,1 =\frac{16}{\pi 35^3}\left[15000+\sqrt{15000^2+34.10^2}\right]$$

$$\delta\,1 =\frac{16}{\pi 35^3}\left[15000+\sqrt{225{,}001{,}162.8}\right]$$

$$\delta\,1 =\frac{16}{\pi 35^3}\left[15{,}000+15{,}000.04\right]$$

$$\delta\,1 =\frac{480{,}000.62}{\pi\;x27000} = 35.65\text{N. mm}$$

Therefore Design is safe because 54.34N.mm>35.65N.mm

Experimental investigation suggest that maximum principle stress theory gives good prediction for brittle material that are made up of ductile material, like steel and therefore it is not applicable to shaft design.

II. maximum shear stress is theory is the principal shear stress

$$\delta_{max} =\frac{16Mt}{\pi d^3}\sqrt{mb^2+mt^2} \text{....................eq 11}$$

$$\delta_{max}=\frac{16}{\pi d^3}\sqrt{15000^2+34.10^2} = 28.3\text{N. mm}$$

δ_{max} =the lower of the two values is and there are key ways on the shaft must be T_{max}=0.75x54.34N .mm^2 =37.5N.mm

So, **the design is safe 37.5N.mm>28.3N.mm**

III. Equivalent torsional moment of the expression called $\sqrt{mb^2+mt^2}$

$T_e = \sqrt{mb^2 + mt^2} = \sqrt{15000^2 + 34.1^2} = 15000N.mm$

IV. Equivalent torsional moment

$T_b = \left[Mb + \sqrt{mb^2 + mt^2}\right]$

$T_{eb} = \left[15000 + \sqrt{15000^2 + 34.1^2}\right] = 30000N.mm$

ASME code shaft design Value of shock and fatigue factor kb and kt

Where kb=fatigue factor

Kt=shock factor

Table 4.13 ASME code for shaft design Value of shock and fatigue factor

	Application	**Kb**	**kt**
1	Load gradually applied	1.5	1.0
2	Load suddenly applied (minor shock)	1.5-2.0	1.0-1.5
3	Load suddenly applied (heavy shock)	2.00-3.00	1.5-3.0

$\delta_{max} = \frac{16Mt}{\pi d^3}\sqrt{(kbmb)^2 + (ktmt)^2}$.........eq 12

$\delta_{max} = \frac{16Mt}{\pi d^3}\sqrt{(1.5\ x15000)^2 + (1.34.10)^2}$ =42.5N.mm

Therefore the design are safe because 54.34n/mm^2>42.5N.mm^2

$\delta\ 1 = \frac{16}{\pi d^3}\left[kbmb + \sqrt{(kbmb)^2 + (ktmt)^2}\right]$

$= \frac{16}{\pi d^3}\left[1.5\ x15000 + \sqrt{(1.5\ x15000)^2 + (1\ x34.10)^2}\right]$

$= \left[22{,}500 + \sqrt{(22{,}500)^2 + (34.10)^2}\right]$

= 53.43N.mm

Also the design is safe because 54.34mpa >53.43mpa

4.3.1 Design of pulley

Pulleys are used to transmit power from one shaft to another by means of belts. Since the velocity ratio is the inverse ratio of the diameters of driving and driven pulleys, therefore the pulley diameters should be carefully selected in order to have a desired velocity ratio. The pulleys must be in perfect alignment in order to allow the belt to travel in a line normal to the pulley faces.

Material to be selected for the pulleys should satisfy the following requirements. These are:

- Light weight- Should be local
- Less cost
- Easily manufactured- Non-corrosive
- Have a moderate strength

Applicant materials to manufacture the pulleys are Aluminum, wood, Cast iron and steel. Aluminum is light in weight, can be easily machined non-corrosive, available on market and possesses moderated strength but comparatively it is expensive than wood and steel. However, since the torque on the pulley can easily break the wood and the steel may add extra load on the shaft and it corrodes, therefore our selected material for the pulley is **Aluminum**.

Two different diameters of pulleys with smaller diameter on the motor shaft and larger diameter on the roller shaft is designed to reduce the RPM of roller shafts to have gradual feed of the concrete mixing machine. For the case of this design, it is decided to have a **velocity ratio of 1:4.**

According to Indian Standards, the V-belts are made in five type's i.e. A, B, C, D and E. The dimensions for standard V-belts are shown in Table 4.14.So the smaller pulley diameter is selected from the standard table which is 75 mm.

Table 4.14 Dimensions of standard V-belts according to IS: 2494 – 1974.

Type of belt	Power ranges in kw	Minimum pitch diameter of pulley (D)mm	Top (b)mm	Thickness (t)mm	Weight per Meter length in Newton
A	0.7 - 3.5	75	13	8	1.06
B	2 – 15	125	17	11	1.89
C	7.5 – 75	200	22	14	3.43
D	20 – 150	355	32	19	5.96
E	30 – 350	500	38	23	-

Now from the selected small diameter of pulley and velocity ratio (VR), it can calculate the large pulley diameter on the roller shaft.

Now from the selected small diameter of pulley and velocity ratio (VR), it can calculate the large pulley diameter on the roller shaft.

$VR = \frac{d}{D}$.................................... Eq(13)

$= \frac{75\ mm}{D}$ Where d – is diameter of small pulley on the motor shaft;

D – is diameter of larger pulley on the drive shaft;

the large diameter adopted 250mm- 500mm is recommendable from standard table in machine design book table 17 page 455.

Now by taking **1400 RPM** of motor (on smaller pulley), the RPM of the larger pulley (on the driven shaft) is given by $dxn_1 = Dxn_2$ where n1 –is RPM of smaller pulley. N2- is rpm of larger pulley

$n_2/d = n_1/D$ $n_2 = n_1xd/D$ n_2 = 1400rpmx75 mm/300mm = 350rpm

n_2 =350rpm

let as now the pulley speed 25m/sec

V = 25m/secx75mm/300mm= 6.25m/sec

So the design is safe 25m/sec >6,25m/sec

<u>Force analysis of small pulley</u>

We know that power transmitted (in watts) by the shaft,

$P = \frac{T}{\omega}$, $\omega = \frac{60}{2\Pi n}$ so, $T = \frac{Px60}{2\Pi n}$ Where T- is twisting moment in N-m

n - is speed of shaft in RPM = 1400 RPM

P-is power required =2.5wat

$T = \frac{2.5x1000\ wattx60}{2\Pi x1400}$ = **<u>17052.315 N-m</u>**

Free body diagram of the force and moment acting on small pulley train

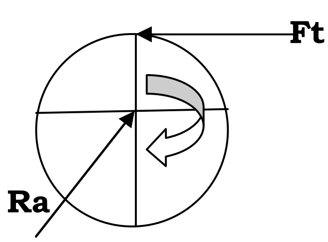


Figure 4.10 Free body diagram of force analysis on the pulley

Tangential force (Ft)

$$Ft=\frac{2Tp}{Dp}.....................................eq(14)$$

where Ft= Tangential force

Tp= torque transmitted by pulley

Dp= diameter of small pulley

$$Ft) = \frac{2x17052.213}{30} = 1136.8N$$

FR=Fttan(ɵ)................................eq(15)

@ Radial force(Fr) =Pr =FR=$F_t$tan(ɵ)

(Fr) =1136.8x tan40^0 =953.9N

$$(Fr)=\frac{Ft}{\cos\theta} \quad ....eq(16)$$

Resultant force $(Fr)=\frac{Ft}{\cos\theta}$

(Fr) $= \frac{1136.8\,N}{cos400ɵ}$ =1483.99

Pulley bending

@reliability of material (R) =0.95

@No. of load cycle (N)= 10^9

K=1

@ and design factor =2.5

$V=\frac{\pi DNP}{60X1000} = \frac{\pi 300x1400}{60X1000} = \frac{21.98m}{s}$

Dynamic factor of shaft (KV) $=\left[\frac{A+V^{0.5}}{A}\right]B$

A= 56+56(1-B)

B= 0.25(12-QV) Where QV= 0.8255 it comes from machine design Norton

A =56+56(1-0.8255) =59.77

Whereas KV =59.77+779.21$(0.5)^{0.825}\frac{59.77+779.21(0.5)0.825}{59.77} = 1.372$

Then bending stress on small pulley

$\delta = \frac{WtxKoxKvxKsxPdxKmx\ Kb}{FxJp} = \frac{142\,x1.372\,x1.0396\,x8.466\,x1.2994\,x1}{1.811\,x0.32}$ **=5895.127psi**

4.3.3 Determination of Belt Length.

For any type of the belt drive it is always desirable to know the length of belt required. It will be required in the selection of the belt. The length can be determined by the geometric considerations. However, actual length is slightly shorter than the theoretically determined value.

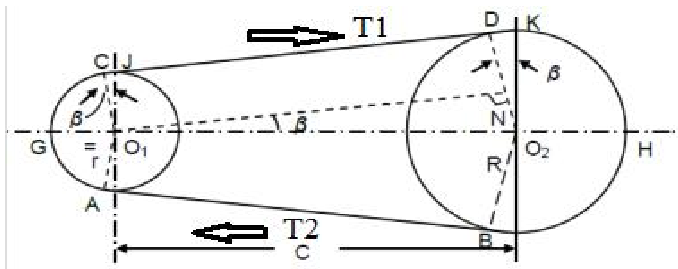


Figure 4.11 Belt drives(From Engineering Data book for v – belt.)

The belt drive is shown in Figure 4.1. Let O_1 and O_2 be the pulley centers and AB and CD be the common tangents on the circles representing the two pulleys.

The total length of the belt 'L' is given by

L = AB +Arc BH + DC+ Arc CGA, equals to the formula;

$L = 2C + 1.57(D+ d) +((D - d)^2) / 4C$

Where, C= center distance, D = driven pulley (larger pulley), d = driver pulley (smaller pulley)

Let r be the radius of the smaller pulley, R = the radius of the larger pulley,

C be the center distance between the pulleys which is 400 mm based on the design, and β be the angle subtended by the tangents AB and CD with O_1O_2.

By geometry, $< O_2O_1N = < C\ O_1\ J = < DO_2K = \beta$

Arc BHD = $(\pi + 2\beta) R$, and Arc CGA = $(\pi + 2\beta)r$

$AB = CD = O_1N = O_1\ O_2 Cos\ \beta = C \cos \beta$

$\sin \beta = (D - d)/C = (300-75)/400 = 0.5625$

$\beta = \sin^{-1}(0.5625) =$ **<u>34.23^0</u>**

$L = 2C + 1.57(D+ d) + (D - d)^2 / 4C$

$L = 2(400) + 1.57(300 + 75) + \frac{(300-75)2}{4x400}$

= 800 + 588.75 + 31.64

= **<u>1420.39</u>** mm

From standard table, SPZ it is close to the datum length = 1420mm and inside diameter, Li = 1400 mm.

Therefore, belt specification for this machine is **ZX 55 x 1400 Li and 1420 L** is selected based on the following table. These data are suitable and ISO standard because it describes the relations of center distance, pulley diameters and belt dimensions. In addition, it guides to select standard sizes and appropriate movements.

Table 4.15 Torque f l e x ® v- belt s (ISO standard of Good year's Belt products)

Belt reference	**Imperial reference (inch)**	**Inside length Li (mm)**	**Datum length Ld (mm)**
ZX 53 ½ 53 ½ 1365			1385
ZX 53 ½	53 ½	1365	1385
ZX 54	54	1375	1395
ZX 54 ½	54 ½	1390	1410
ZX 55	**55**	**1400**	**1420**
ZX 56	56	1425	1450
ZX 57	57	1450	1470
ZX 57 ½	57 ½	1465	1485
ZX 58 ¼	58 ¼	1475	1500
ZX 58 ½	58 ½	1490	1510

Contact Angle of belt and pulley

These angles are important because commercially available belts rated with on assumed contact angle of 180^0. This will occur only if the drive ratio is 1:1(no speed change). The angle of contact on the smaller of the two pulley will always less than 180^0, requiring a lower power rating. The tensile force in the belt maximum on the tight side of the belt. The bending of the belt around the pulley, maximum at the tight side of the belt bends around the smaller pulley.

Where, θ_1 = Contact angle of belt on small pulley.

θ_2 = Contact angle of belt on large pulley.

L = Belt length.

C = Center distance between pulleys

<AGC = θ_1 = $180^0 - 2\sin^{-1}[\frac{D-d}{2C}]$

< BHD = θ_2 = $180^0 + 2\sin^{-1}[\frac{D-d}{2C}]$

Contact angle of small pulley (θ_1) ***Contact angle of large pulley (θ_2)***

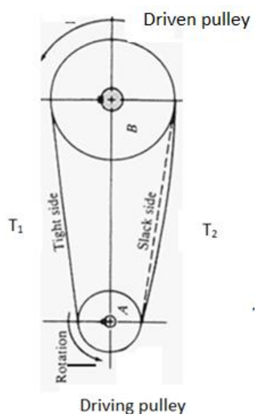
$\theta_1 = 180 - 2\sin^{-1}[\frac{D-d}{2C}]$ $\theta_2 = 180 + 2\mathrm{Sin}^{-1}[\frac{D-d}{2C}]$

$= 180 - 2\mathrm{Sin}^{-1}[\frac{300-75}{2x400}]$ $= 180 + 2\mathrm{Sin}^{-1}[\frac{300-75}{2x400}]$

$= 180 - 2\mathrm{Sin}^{-1}[\frac{225}{800}]$ $= 180 + 2\mathrm{Sin}^{-1}[\frac{225}{800}]$

θ_1 = **$\underline{\underline{147.33^0}}$** θ_2 = **$\underline{\underline{212.67^0}}$**

Tensions of belt



P = (T1-T2) V

Where, T_1- is tension on the tight side of belt

T_2 - is tension on the slack side of belt

V- is velocity of the belt in small pulley

P -is power from the above design =2,5x10^3 watt

That is $V = \frac{\pi dN}{60} = \frac{\pi x 75 x 1400}{60}$ = 5495 m/s

Therefore, T_1-T_2 = P/V $= \frac{2.5x103}{5495 m/sec}$

Figure 4.12 Belt tension

T_1-T_2 = 0.645N ………………….eq(17)

2.3 log ($\frac{T1}{T2}$) = μ where, μ- is coefficient of friction between the smaller pulley and v-belt by taking μ= 0.12 from table μ - is contact angle on small pulley in radian that is 147.33^o = 2.57 rad

2.3 log ($\frac{T1}{T2}$) = 0.12x2.57

log ($\frac{T1}{T2}$) = $\frac{0.12x2.57}{2.3}$ = 0.134

$\frac{T1}{T2}$ = 1.36 by taking anti log of 0.134

T1=1.36T_2…………………………eq(18)

Therefore by combining the two equations, that is:

$1.36T_2 - T_2 = 0.645N$ $\Longrightarrow$ $T_2 = \frac{0.645N}{0.36} =$ **<u>1.8N</u>** in the slack side

$T1 = 1.36T_2 = 1.36x\ 1.$ $\Longrightarrow$ $T_1 =$ **<u>2.45N</u>** in the tight side

Square sunk key: the only difference between a rectangular sunk key and a square sunk key is that its width and thickness are equal, i.e w=t=d/4

There two failure mecanism of key :-

1. When it can be sheared during stress (Torsional shear stress in the key)
2. When it can be crushed due to the comprehensive bearing force

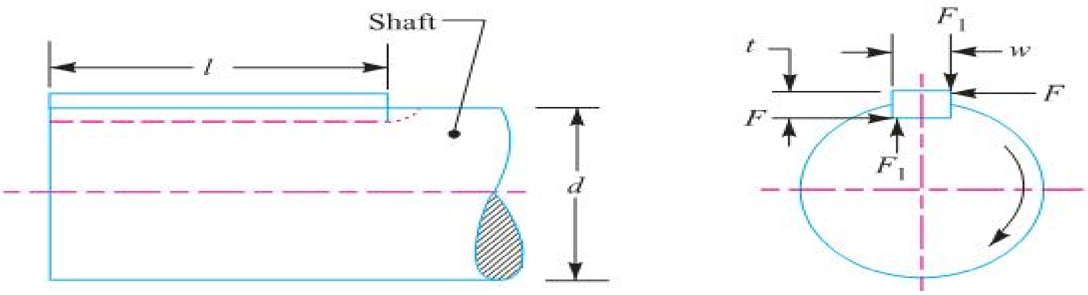


Figure 4.13 Force acting on the key

Let T=Torque transmitted by the shaft

F=Tangential force acting at the circumference of the of the shaft

D=Diameter of the shaft

L=length of the key

W=width of the key

T=thickness of the key, and

$\tau and \sigma_c$ =Shear and crushing stresses for the material of key

Shear force F = Area of resisting shear x shear stress

F = L x w xτ............4.12

T= F x d/2, T = L x w x τx d/17060.198 mpa = Lx10x40 N/mm^2 x30/2

L = 17060.198/10x8x40

L= 5.33mm

1. **Torsional shear stress in the key**

$\tau = Tr/J$ let τ =shear stress on the shaft

T = torque transmitted by the shaft

r= radius of the shaft

J = polar momentum of the solid shaft

$\tau = Tr/J$ =221596.88mpax15mm / 79481.21 τ =42.5mpa

2. When it can be crushed due to the comprehensive bearing force

Shear force F = Area of resisting crushing x crushing stress

$F = L \times t/2 \times \sigma_c$ ....eq(19)

We know that T= F x d/2

$T = L \times t/2 \times \sigma_c \times d/2$ ....eq(20)

17060.198 N-mm = Lx4x70 N/mm^2 x30/2

L = 17060.198/15x4x70 = **40.62 mm**

Taking the larger of the two values, developers have length of key.

L = 40.62 mm say **<u>40.62 mm.</u>**

So the design is safe 54.45mpa >42.5mpa because the shear stress of key is less than the permissible value

According to H.F moore the shear strength factor

e = 1-0.2(w/d) -1.1(h/d) ....eq(21)

Where e =effect of factor the keyway

w = width of the keyway

d = diameter of the shaft

h = height of the keyway

e = 1-0.2(w/d) -1.1(h/d) = 1-0.2(7.5/30) -1.1(5/2x30)

e =0.8125

Therefore, strength of the shaft with

keyway $=\pi/16 \times \tau \times d^3 \times e = \pi/16 \times 40mpa \times 30^3 \times 0.8125$ =17466.162 N

and strength the of the key = $L \times w \times \tau \times d/2$

= 40.33x10x40mpax30/2

= 241980N

$$\frac{Shearstrengthofthekey}{Normalstrengthoftheshaft} = \frac{241980N}{17466.16N} = 1.39$$

So the key is in good design condition

From the design of pulley, the tangential force F_t applied to the rotating the belt by on the pulley 448.68N. This force acts perpendicular to the face of the pulley groove that is resulting in shearing of bolts along their axis. This force is equally distributed through the four bolts. Therefore the force applied in each bolt is half of the tangential force i.e $F_b = 0.5F_t = 0.5x448.68N= 224.34N$
Using maximum shear stress theory,

$\tau_{max} \leq 0.75\sigma_y/n$ ....eq(22)

Because the shaft is keyways

Where τ_{max}-is the maximum shear stress

σ_y - is yield strength of bolt and

n –is factor of safety, by taking n = 5

The bolt has high yield strength which low or medium carbon steel (Property class 5.8) having yield strength of σy = 520Mpa from data books.

$\tau = 0.75x520/5 = \underline{78N/mm^2}$

Thus $\tau= F_b/A$ Where F_b– is force applied on bolt = 224.34N

A –is stress area on bolt = $\Pi d^2/4$, d is diameter of bolt

$T=\pi\frac{\tau d^3}{16}$ .... Eq (23)

where d = for the shaft

τ = Shear stress of the bolt

T = 170609.451mpa x4 = 682437.804mpa

682437.80mpa $=\pi\frac{\tau 30^3}{16}$ τ= 128.79mpa

Let d1 = Nominal diameter of bolt since the diameter of shaft is 30mm let as take the number of bolts n=4

And pitch circle diameter of bolt D1= 3d

D1 = 30x3 =90mm

torque transmitted, $T = \frac{\pi}{4}(d_1)^2 \; \tau_b \times n \times \frac{D_1}{2}$

From this equation, the diameter of bolt (d_1) may be obtained. Now the diameter of bolt may

Where T= torque transmitted by shaft

d_1 = diameter of bolt

τ = shear stress of the bolt

n= number of bolt it depends on the shaft diameter

D1= pitch circle of diameter of bolts

$T = \pi/4 x d1^2 x \tau x n x D1/2$ -------------eq(24)

682432.804mpa = π/4x128.79mpa x4x45d²

$d = \sqrt{\frac{682432.804}{4549.51}} = 6.124mmm$

The coarse tread is the nearest standard size of bolt is M10 is safe take from the standard table from machine element V.BBHNDARI page 460.

$\tau = 2T/\pi d^2 D$----------------------------eq(25)

$\tau = 2x225196.88/3.14x60^2 x\ 90 = 44.2708$ mpa

Since the induced shear stress on the bolt is less than the permissible shear stress

54.34mpa >44.2708mpa so the design is safe.

Gear ratio

Spur gear ratio

Mg=np = Zp

Np = Zp

= 1400/560 Rpm

= 2.5 &

Mg = Zg/Zp since ZP = 14 minimum number of pinion gear

2.5 = Zg/18 Zg = 45

Spur gear ratio 20 ;560 or 1 ;28

Assume 20^0 depth involves profile module m =3

M = 1 25.4 = 3 pd = 25.4 = 8.466in(215.05mm)

$Pd = 180.61mm$

Pitch circle = π =3.14 = 0.371inx9.425mm =215.05mm

Pinion pitch =Zp =18 = 2.13in x 25.5 =54mm

Gear pitch Zg = 45 = 5.315in(127mm)

Center distance (C) =dp +dg /2 =45mm+127mm / 2 = 94.5mm

Addendum (a) =1= 1= 3mm

Dedendum (b) = 1.25 =0.1476in(3.75mm)

Whole depth pitch (ht) =a –b =3.75 -3mm =0.75mm

Outer pinion diameter Dp = Dp +Za =54 +2x3 = 60mm

Outer gear diameter (Dg) = dg-za =127- 2x3mm = 141mm

Standard face width = 3π <F< 5π =(reference1)

Fw =30mm =10 =pd

Contact ratio

$L = (rp+a)^2 - (rpcos\varnothing) + (rg + a)^2 - (rpcos\varnothing^2) - sin20^0$

$L = (27mm + 3mm)^2 - (27mmcos20^0)^2 + (67.5mm+3mm)^2 - sin20^0$

$L = 94.5mmsin20^0 = 14.45mm$

Mp = 14.45mm/8.857mm = 1.63mm

Forces analysis of spur gear

Tp =MgxÇp = 2.5x 17052.315N/mm =42630,7875N.mm

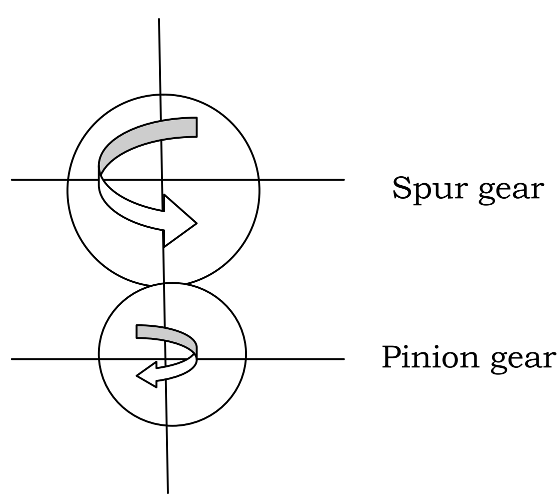


Figure 4.14 Force analysis of gear

Tangential force = $2xTp/dp = 2x17052.315$ N.mm/ 54mm 631.567N

Radial force (fr) = pr =Fr = Ft tanØ = $631.567 x \tan 20^0$ =229.87N

Resultant force = $631.57 / \cos 20^0$ 672.1N

Material selection of gear

Based on the material selection guidelines of candidate material for gear should have good strength (especially fatigue strength) , high stiffness good machinability & in some application good corrosion resistance steel alloy gray steel, cast iron bronze. Steel gear are widely used because of high strength, good resistance & moderate cost but because of wear resistance requirement steel gears usually heat treated to produce a hard surface on the teeth. For our spur gear material we used cast iron.

Heat treatment of shaft

Annealing consists of heating the metal to a suitable temperature, holding at that temperature for a certain time (called soaking), and slowly cooling. It is performed on a metal for any of the following reasons:

(1) To reduce hardness and brittleness,

(2) To alter microstructure so that desirable mechanical properties can be obtained,

(3) To soften metals for improved machinability or formability,

(4) To recrystallize cold-worked (strain-hardened) metals, and

(5) To relieve residual stresses induced by prior processes.

Different terms are used in annealing, depending on the details of the process and the temperature used relative to the recrystallization temperature of the metal being treated.

Full annealing is associated with ferrous metals (usually low and medium carbon steels); it involves heating the alloy into the austenite region, followed by slow cooling in the furnace to produce coarse pearlite. Normalizing involves similar heating and soaking cycles, but the cooling rates are faster. The steel is allowed to cool in air to room temperature. This results in fine pearlite, higher strength and hardness, but lower ductility than the full anneal treatment.

Material	Annealing Temperature(^{0}C)
Dead mild steel(Carbon<0.15%)	870-930
Mild steel(Carbon<0.15-0.3%)	840-870
Medium carbon steel(Carbon<0.3-0.7%)	780-840
High carbon steel(Carbon<0.7-1.5%)	760-780

Soaking time may be given in the rate of 3-4 minutes for everyone mm thickness of the cross section of materials.

In annealing, the work piece is allowed to cool inside the furnace only after switching off electrical power or oil supply to the furnace. This ensure that the workpices cool at a very slow rate. This process results in softening of material and increase inductility due to grain growth.

Normalizing: Normalizing entails heating to the same temperatures as recommended for annealing (except for high carbon steel specimens, which are to be heated to much higher temperatures than for annealing particularly as carbon percentage in sample increases), soaking and then cooling the sample in still air. Main object of normalizing is getting rid of internal stresses and grain-refinement.

Hardening: Hardening involves heating (to the same temperatures as in case of annealing) and soaking. Thereafter, the work piece is taken out of the furnace and quickly cooled at a very fast rate in a tank of cold water or oil, agitating the water/oil vigorously. (This cooling operation is called“quenching.”) The result is hardening of the work piece. However, in order to harden, the carbon content, the work piece should be at least 0.25%. Therefore, dead mild steel cannot be hardened in this way. Mild steel will also harden slightly for specimens containing over 0.25% carbon. Higher the carbon percentage, higher will be resulting hardness. Hardened pieces become brittle and their extreme brittleness becomes a great disadvantage. They tend to fail in-service. Therefore hardening process is invariably followed by a tempering process.

Tempering: Tempering means giving up a certain amount of hardness but shedding a great deal of brittleness acquired in the process of hardening. It is a tradeoff between hardness and brittleness, so that hardened component may give useful service without failure. Tempering involves heating the carbon steel part to a temperature varying from 150°–600°C (depending upon how much trade off is required) and cooling the component in an oil or salt bath or even in air.

Case hardening: As mentioned above, only those carbon steels can be hardened whose carbon content is about 0.25% or more. How do we harden dead mild steel? The answer is by case hardening. In this process, the work piece is packed in charcoal and heated as in annealing. It is kept at that high temperature for a few hours. The result is that carbon enters into the surface of the work piece to the depth of a mm or two depending upon the heating time. The work piece now has a case where carbon percentage is as per requirement for hardening. It is then heated and quenched in the usual manner. The result is a component whose surface acquires hardness, but core remains soft and tough.

Radial Arm length of the shaft

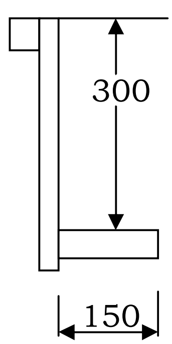


Figure 4. 15 Arm length of the shaft

We applied Newton 2nd law of motion when the torque is applied to rotating bodies that states the torque is directly proportional to the rate of change of angular momentum

$\tau = \frac{d(I\omega)}{dt}$

Angular momentum

A=Iω

Where I is mass momentum of inertia

ω is angular velocity of the body

$\frac{d\omega}{dt}$ = Angular acceleration

$p = \frac{\omega}{t}$

2.5kw=$\frac{w}{60\,\text{min}}$ because speed reduction by gear and pulley ratio 1:4 and 1:9 are 350 rpm and 560rpm

2.5kw=$\frac{w}{60\,\text{min}}$

W=41,666.67J

Therefore, W= FxL

Where W is work done

F is force

L is arm length of the shaft

41,666.67N-m = FxL

L=$\frac{41{,}666.67}{200x9.8}$ =300mm

Potential Energy

PE = mgh

PE = 200kgx10x940mm

PE = 1880000N-m

Therefore, the radial arm length obtained from

W=$\frac{1}{2}sx^2$

41,666.67=1/2 x 450.89mm.x^2

X=29.78cm =300mm

4.4 Ergonomics considerations

Human aspects play an important role in the ergonomic considerations. An effor thas been made to understand the muscular problems faced by the workers while manually concret mixing machine

Optimum metrics were obtained for operators of different heights and a customizable design of our machine is proposed to enhance the ergonomical considration to the machine. All design decisions were made based on anthropometric data of an average person.

The design of the machine is mainly aimed to solve the problems such as musculoskeletal injuries, back strian that come due to the awkward postures of the traditional and manual method of mixing process by using crank shaft (handle). The main ergonomics feature in this design is the presence of a comfortable driving mechanism that suits for medium age and any sex groups of people.

CHAPTER FIVE

MANUFACTURING PROCESS AND ASSEMBLY

This chapter deals with the process and Operation sheet for critical components, Procedures of assembling components and maintenance of the project.

5.1 Manufacturing process

Manufacturing process is part of the production process which is directly concerned with the change of procedure or dimensions of parts being produced. It is usually carried out as a unit operation, which means that a single step in the sequence of steps required transforming the starting material into a final product.

Manufacturing is derived from the Latin word 'manu-factus', means made by hand. In modern context it involves making products from raw material by using various processes, by making use of hand tools, machinery or even computers. It is therefore a study of the processes required to make parts and to assemble them in machines.

5.1.1 General steps to manufacture components of the machine:-

- ❖ Taking the material for the component according to the design parameters and material selection.
- ❖ Assuring the selected material dimension and parameter by proper measuring tool.
- ❖ Marking (layingout) the selected material to the recommended dimensions.
- ❖ Selecting the appropriate machining process or tool for cutting the material to prepare the rough dimension.
- ❖ Keeping selected material in the selected machine or tool to make the rough dimensions.
- ❖ Accomplishing the operation within the recommended and measured dimension on the marked line with recommended allowance.
- ❖ Making the joining operation (welding, bolt & nut, …)

- ❖ Checking the recommended dimension and parameter.
- ❖ Polishing the assembled component according to the recommended finishing process.
- ❖ Painting if it is necessary
- ❖ Making ready the component for assembly.

Manufacturing operation

During manufacturing process we have considered the basic manufacturing steps such as process operation and assembling operation.

The manufacturing process used in the fabrication of the concrete mixing machine is such that the total cost of fabrication is reducing and also one that can make use of the available materials. The manufacturing process involved in this work includes, cutting materials using either hand or power hack saw, machining, joining of metal parts using welding, bolt and nut. Each component of the machine is fabricated separately before they are joined or welded together. The following are the procedure of fabrication of each component of final products.

Main frame or stand of the machine

The frame supports the entire machine which is made by joining (Length 2200, Width 50, Height 50 and Thickness 2mm) square pipe to make the overall dimension of it to length 1400, width 980, and height 900mm and shape it by welding.

Two tires having a height of 190 mm each were welded with the end of plates attached to tires by bolt 980x40x70mm pipe at the bottom of the frame of one side for easily movement of the machine. The inclined angles were designed to 120^0 from the horizontal to have better ground gripping.

Part number: 01

Material: Steel

Quantity: 1

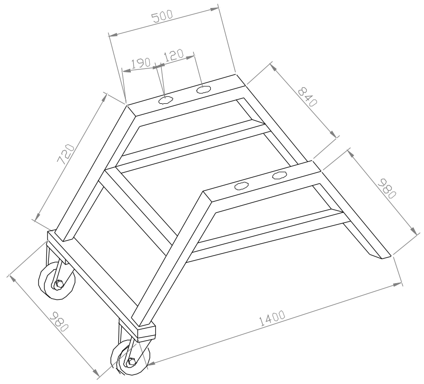


Figure 5.1 Frame of the machine

Table 5.1 Manufacturing procedure of the body frame

Op. no.	Description of job			Tool and cutter description	Depth of cut(mm)	Time		Machining cost	
						Setup hrs	Machining time hrs	Rate Birr/hr	Cost Birr
1	0	cut the pipe to the desired length	cutting end of the pipe to 45 deg. from each layout	combination square, hacksaw	70.7	0.15	0.25	40	6
	1		removing the notches to form angle of 120 deg	combination square, hacksaw	67.8	0.25	0.50	35	8.75
2	0	Drill the holes through the marked points	Setting up collate chuck, swivel the vertical milling head and drill the holes to diameter 12 and depth 50mm	drill bit, collate chuck	50	0.40		30	12
	1		Enlarging the drilled hole to diameter 18mm using larger drill.		50	0.30	0.5	25	7.5
	2		finish the hole to diameter 30H7	reamer	0.1	0.2	0.11	20	4
3	0	Join the cut portion by welding	setting up the welding machine to the recommended ampere		0.2	0.1	0.1	50	5
	1		Welding the components	ø3.2 electrode	0.9	0.07	0.5	200	100
	2		removing slag and chips	chipping hammer, wire brush	0.3	0.04	0.15	30	4.5

Main (Drum) shaft manufacturing Process

The procedures to produce the Main (Drum) shaft are:

1. First we prepared a bar of Ø38mm.
2. With a power hack saw, we cut the bar to a length of 260mm.
3. Then, using lathe machine the ends of shaft is faced to produce a length of 250 mm.
4. Rough turn one end of the shaft to 36.5mm diameter to a length of 250 mm.
5. Finish turns this end of the shaft to 35mm diameter.
6. Set a milling machine to cut key way on the stepped end of the shaft.
7. Using end mill cut a key way of length and width 20mm and 8mm for pulley respectively.

Part number: 02
Material: Mild steel
Quantity: 01

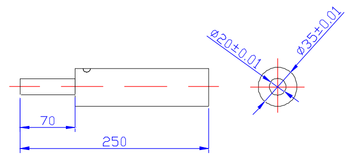


Figure 5.2 Main shaft

Table 5.2 Manufacturing procedure of the main shaft

Op. no.	Description of job			Tool and cutter description	Depth of cut(mm)	Speed				Time		Machining cost	
						Cutting speed		Feed					
						speed in m/mi	n(RPM)	mm per tooth	mm per rev	Set up hrs	Machining time hrs	Rate Birr/hr	Cost Birr
2	0	Machine the main or drum shaft	Preparing and cutting Ø38mm bar to a length of 260mm using lathe machine.	lathe cutter	19	96	2546.9			0.15		200	30
	1		facing to produce a length of 250 mm.		0.5					0.25		200	50
	2		turning one end of the shaft to 36.5mm diameter to a length of 250 mm		0.25								
	3		Finishing turn the end of the shaft to 35±0.05mm diameter.		0.2								
	4		Setting a milling machine to cut key way on the stepped end of the shaft.										
	5		Using end mill, cut a key way of length and width 20mm and 8mm for pulley respectively	Milling cutter	4					0.1	0.1	50	5

Pulleys production

It is one of the machine element used to transmit motion from the smaller pulley to the driver shaft through V-belt. Since its size is larger than smaller pulley, it has an advantage of reducing speed of rotation of AC motor by one-fourth to have less speed on driver and driven shafts. It can be manufactured from aluminum/cast/by using casting iron process. But we designed to use cast iron for better strength and durability. For this reason we directly searched and purchase it from the market due to unavailability of raw materials with specified material type.

Material------------AISI1035

Blank size---------Ø305x26 mm

Quantity----------- 01

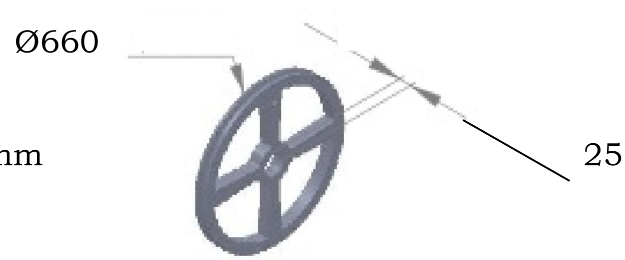


Figure 5.3 Larger pulley

Operation sheet for smaller pulley

It is one of the machine element used to transmit motion from the prime mover to the larger pulley through V-belt. Since its size is smaller than larger pulley, it has an advantage of reducing speed of rotation of AC motor by one-fourth to have less speed on the larger pulley. It is manufactured from aluminum by using machining process.

Material------------ AISI 1035

Blank size---------Ø80x50 mm

Quantity----------- 01

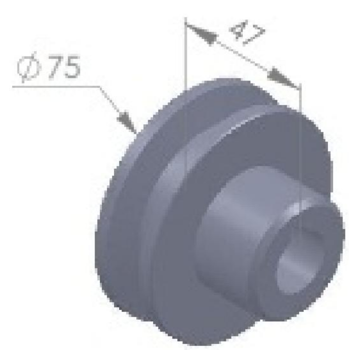


Figure 5.4 Smaller pulley

Table 5.3 Operation sheet for smaller pulley

No.	Operation	Machine used	Tools & Equipment's used	Dimension
1	Measuring & cutting to size	Power hacksaw	Venire caliper, steel rule	Ø = 80 mm L= 50 mm
2	Facing on one side	Lathe machine	carbide cutter & V. caliper	Ø = 80 mm L= 48.5 mm
3	Turning and chamfering	Lathe machine	Carbide cutter Vernier Caliper	Ø = 75 mm L= 48.5 mm
4	Facing on the other side	Lathe machine	Carbide cutter Vernier Caliper	Ø = 75 mm L=47 mm
5	Turning a hub and chamfering	Lathe machine	Carbide cutter Vernier Caliper	Ø = 40 mm W= 24 mm
6	Drilling	Lathe machine	Center drill, Drill bit And V. Caliper	Ø =24 mm D= 47 mm
7	Milling a key way	Milling machine	Slotting attachment with HSS cutter	6x3.5x47 mm

Mixing blade production

It is one of the machine components of concrete mixing machine which is made from mild steel plate with 6 mm thickness. The purpose of mixing blade is to stir aggregates, cement, sand and water during mixing or combining. They play a significant role in making the concrete with homogeneous output. They are three in number attached to the side of the drum by bolt and nut.

Operation sheet for mixing blade

Material: AISI 1820

Blank size: 500x40x6mm

Quantity: 03

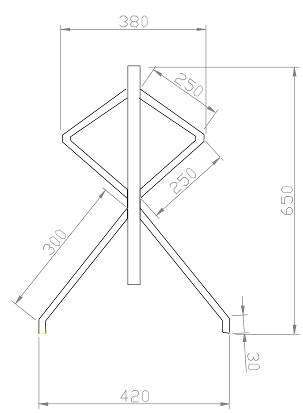


Figure 5.5 Mixing blade

Table 5.4 Operation sheet for mixing blade

No.	Operation	Machine used	Tools & Equipments used	Dimension
1	Measuring & cutting to size	Hand shear	Steel rule and tape rule	W= 50mm L= 500 mm
2	Drilling	Bench type drilling machine	M10 Ø10 mm	Center to center 452mm
3	Connecting with drum	Bolt and nut of M10	Adjustable wrench	

Gear manufacturing

Gears are used extensively for transmission of power. They find application in automobiles, oil engines, machine tools, industrial machinery, agricultural machinery, geared motors, etc. To meet the strenuous service conditions the gears should have robust construction, reliable performance, high efficiency, economy and long life. Also, the gears should be fatigue free and free from high stresses to avoid their frequent failures. Gear drives should be free from noise, chatter and should ensure high load carrying capacity at constant velocity ratio.

Spur gears are the most common type, which transmit power or motion between parallel shafts or between a shaft and a rack. They are simple in design and measurement. In our machine, the shafts are parallel and revolution per minute is low and no significant noise.

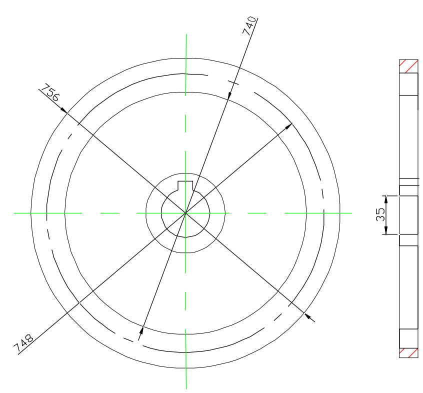


Figure5.6.Spur gear

The procedures to produce the pinion gear are:

1. First, we prepared a bar of diameter 60mm.
2. With a power hack saw, we cut the bar to a length of 40mm.
3. Then, using a lathe machine the end of bar is faced and finished to a length of 35 mm.
4. The gear blank is first rough turned to 52mm diameter using a mandrel mounted between centers. Then, it is finish turned to 51mm and the blank should remain on the mandrel after turning.
5. The blank is drilled using 10mm diameter drill by inserting it in chuck on lathe machine. The hole is rough enlarged to 29mm and then finish enlarged to 30mm using boring tool on lathe machine.
6. Then, key way is cut through the inner bore to assemble it on a shaft.
7. The table of the milling machine and the bottoms of the dividing head and tail stock should be cleaned. Clamp the head stock of the dividing head in the center slot of the table in a location suitable for the work.
8. Check the spindle of the dividing head with the test bar and indicator to be certain that it is parallel to the table.
9. Depending on the length of the work, clamp the tail stock in proper position.

Align the tail stock center with the headstock center. Center and align the cutter with the dividing head or head stock center.

10. The lathe dog should be wedged against the faceplate to eliminate backlash and the indexing head mounted to the lathe spindle to position the individual teeth.
11. The basic unit is mounted on the compound rest with the faceplate parallel to the lathe center.
12. An arbor with an in volute gear cutter, stamped with the 6mm circular pitch and number of teeth (24)is installed in the basic unit.
13. After the cutter is positioned, lock down the cross feed by tightening the gibs.
14. When the 4mm depth of teeth is reached, tighten the post locking screw on the basic unit.

15. The cutter is then fed into the blank by hand using the lathe carriage wheel.
16. The procedures are continued until all the teeth are cut and completed.

The standard bearing house

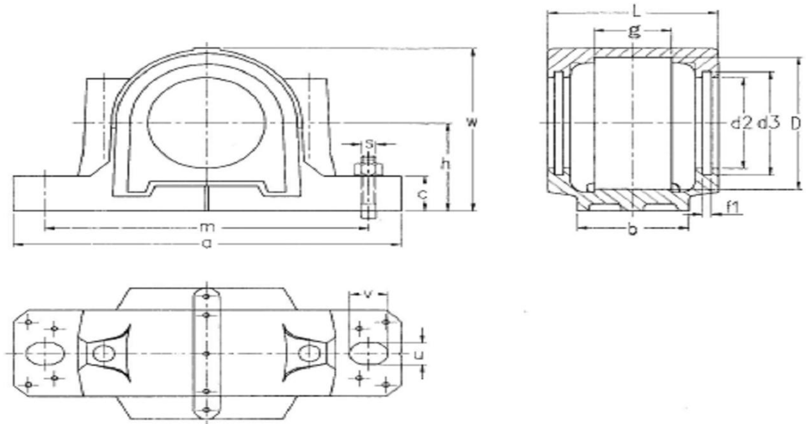


Figure 5.7 Standard bearing House (Catalogue Oko,2005)

The standard bearing house with its bearing is selected for our project was bought from the local market. The selected bearing is self centered type and can resist the load radial on the shaft. The size of the bearing and bearing house selected is based on the standard values indicated on the above table. As it was indicated on the standard table above, the housing number SNG507-606 is appropriate for the shaft diameter of 30 mm. So that, the selected bearing house for the project is the housing number of SNG507-606.

Note: The operation sheet for other parts like driven shaft, motor basement, drum basement, stud bolt, frame, and handle is similar to the operation sheet of parts mentioned above based on size, operation, tools and machines required and their operation sequences are explained in Labor cost for manufacturing components.

Sequence of manufacturing processes

The activities mentioned by table below by table were critical activities and concern has been given to complete the project in time. Thus, the total production time is 136Hr.

Table.5.6 : Sequence of manufacturing processes of the components and assembling of mini concrete mixer machine in time estimates.

Activities	**Activities description**	**Duration Hr**
A	Producing Main frame of the machine	16Hr
B	drum basement	8Hr
C	motor basement	12Hr
D	Drum	12Hr
E	Shaft	10Hr
F	Pulley	8Hr
G	Producing handle	8Hr
H	crank shaft	1Hr
I	Assembling all components	12Hr

Activities A and B can start simultaneously. Activity A followed by D, E, and F. Activity B is followed by activity C,G and H.

Table 5.7 Activities

Activity	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Optimistic time(t_1)	16	8	12	12	10	8	8	1	12
Most likely time(t_2	16	8	12	12	10	8	10	1	12
Pessimistic time(t_3)	17	12	14	14	12	10	16	2	14

Expected time = $\frac{t1+4t2+t3}{6} = \frac{16+4x16+17}{6} = 16.17$

$$\overline{x} = \frac{[x1 + x2 + x3\ \ ]}{n} = \frac{[8 + 8 + 9\ \ ]}{3} = 8.33$$

$$Vairance\ for\ A = \frac{[x1-\overline{x})^2}{n-1} = \frac{[8-\overline{8.33})^2 + [9-\overline{8.33}]^2 + [8-8.33]^2}{3-1} = 0.3$$

Table 5.8 Expected time and variance for each activity

Activity	Expected time	Variance
A	16.17	0.3
B	17.33	5.33
C	24.67	1.26
D	24.67	1.26
E	20.67	1.33
F	16.67	11.37
G	19.33	21.80
H	2	0.34
I	24.67	1.25

5.2 Assembling procedure of the machine parts

The next step after manufacturing process is assembling the components.

- ❖ Fastening the drum base/support, when it is horizontal, to the main frame.
- ❖ Fastening or welding the blade inside the drum body properly by using bolt and nut.
- ❖ Setting the drum on the drum basement or in the middle of beam length of the main frame.
- ❖ Attaching drum and shaft by the help of bolt and nut.
- ❖ Attaching pinion gear at the end of the other shaft which is designed to take motion from the single phase 1hp electric motor.
- ❖ Placing and fastening the motor on u-channel (which is used as the support of the motor, barrel shaft and pulley shaft together with their bearing houses) according to the design.
- ❖ Finally locating and adjusting the belt to the pulleys(motor end pulley and larger) according to the selected belt size and then checking the alignments.

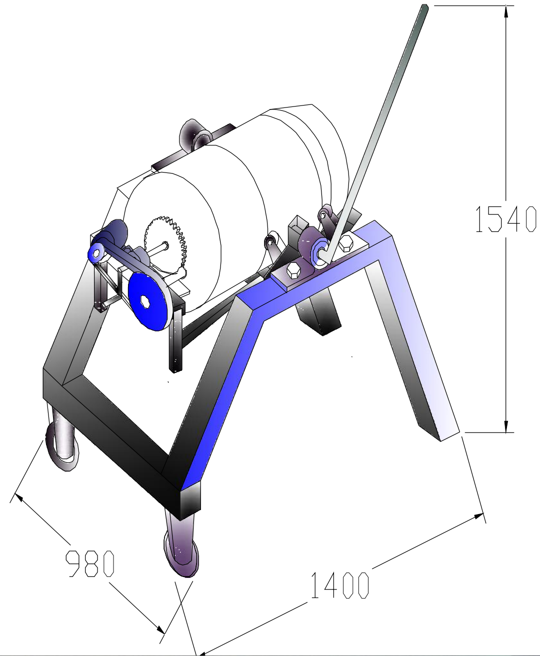


Figure 5.9 Isometric drawing of the object

Subassemblies of the machine

1. Main frame
2. Revolving drum
3. Mixing blade
4. Drum basement
5. Motor basement
6. Motor
7. Hand lever
8. Manual hand driven

The Steps to disassemble the machine components are:

I. Removing the belt from the motor and pulley with safety consideration.

II. Removing the main shaft from the drum.

III. Disassembling main shaft and bearing house and then by loosening the bolts from the u-channel.

IV. Loosening the bolts to disassemble larger pulley, pinion gear and their shaft.

V. Then taking out the shaft, bearing house (bearing) and pulley together from the u-channel.

VI. Removing the bearing house (bearing) from the shaft connected to the discharging lever.

VII. Loosening the mixing blade from inside of the drum.

VIII. Then complete the disassembling mechanism with the required safety procedures.

CHAPTER SIX
COST ANALYSIS AND TEST RESULT

In our project, cost refers to the amount of money invested in the production of the machine. The analysis of this cost may help someone who wants to produce the same machine or to make another design by considering the amount used in this machine as reference or starting cost.

6.1 Cost Analysis

Cost of frame

The cost for body frame is shown in the table below.

Table 6.1 Cost of frame

No.	Item	Quantity	Unit cost	Total cost
1	Mild steel square hollow section 50mm x50mm x 1.5mm	2pcs	420	840
2	Electrode	1pack	220	220
3	Hole drilling by using portable drill	0.5hrs	30.0	15
4	Cutting using hack saw	2hrs	30.0	60
5	Welding using shielded metal arc welding machine	3hrs	30.0	90
		Total Cost		**1225.00**

Cost of Drum support

Table 6.2 Cost of drum support

No.	Item	Quantity	Unit cost	Total cost
1	Mild steel square hollow section 40mm x40mm x 1.5mm	2pcs	380	760
2	Electrode	1pack	220	220
3	Cutting using hack saw	½ hrs	30.0	15
4	Welding using shielded metal arc welding machine	1½ hrs	30.0	45
		Total Cost		**1040.00**

Cost of discharging lever

Table 6.3 Cost of discharging lever

No.	Item	Quantity	Unit cost	Total cost
1	Mild steel round solid bar of Ø30mm and length 1000mm	1pc	320	320
2	Hole drilling by using portable drill	0.5hrs	30.0	15
3	Cutting using hack saw	0.75hrs	30.0	22.5
		Total Cost		**357.50**

Cost of blade guiding shaft

Table 6.4 Cost of blade guiding shaft (inside the drum)

No.	Item	Quantity	Unit cost	Total cost
1	Mild steel round solid bar of Ø25mm and length 400mm	1pc	280	280
2	Electrode	10pcs	2	20
3	Cutting using hack saw	½ hrs	30.0	15
4	Welding using shielded metal arc welding machine	½ hrs	30.0	15
		Total Cost		**330.00**

Cost of U-Channel

Table 6.5 Cost of u-channel

No.	Item	Quantity	Unit cost	Total cost
1	Mild steel of section 1500x80x5mm	1pc	120	120
2	Electrode	20pcs	2	40
3	Cutting using hack saw	½ hrs	30.0	15
4	Welding using shielded metal arc welding machine	¼ hrs	30.0	7.5
		Total Cost		**182.50**

Cost of rotating handle

Table 6.6 Cost of rotating handle

No.	Item	Quantity	Unit cost	Total cost
1	Round hollow pipe of section Ø30mm and length 700mm	1pc	190	190
2	Electrode	8pcs	2	16
3	Cutting using hack saw	½ hrs	30.0	15
4	Welding using shielded metal arc welding machine	½ hrs	30.0	15
		Total Cost		**236.00**

Cost of motor pulley

No	Item	Quantity	Unit cost	Total cost
1	Aluminum Ingot	1pc	200	200
2	HSS Cutter	1pc	60	60
3	Machining by using lathe machine	3hrs	40	120
		Total cost		**400.00**

Cost of shafts

Cost of stock = V =A * L

V = $\prod r^2 x l = \prod x 17.5^2 x 250$ =240,406.25mm^3 =0.00024m^3 where r is radius and l is length of the shaft respectively.

ρ= 7800kg/m3 for iron

m = ρ *v =7800kg/m^3x0.00024m^3=1.872kg

1kg = 170 birr,

170*1.872=318.24 birr

318.24 x4 = 1,272.96, because the quantity of the shaft is four

It took around 320 birr for machining and the overall cost becomes **1,592.96 birr.**

Cost of tires Connection

Table 6.8. Cost of tires connection

No.	Item	Quantity	Unit cost	Total cost
1	Electrode	10pcs	2	20
2	Welding with shield metal arc welding	15min	30	7.5
		Total cost		**27.5 birr**

Cost of mixing blade

Table 6.9 Cost of mixing blade

No	Item	Quantity	Unit cost	Total cost
1	Flat plate 500mmx50mm x 6mm	3	35	105
2	Cutting by hack saw	0.125hrs	25	3.125
3	Drilling using drilling machine	0.25hrs	35	8.75
		Total cost		**116.875 birr**

Cost of components bought from local market

Sometimes it is difficult to manufacture some parts due to unavailability of materials, machines to produce them, and etc. for this reason we directly purchased them from local market.

Table 6.10 Finished parts or standards bought from the local market directly are shown in the following table.

No.	Item	Quantity	Unit cost	Total cost
1	Tires	2pcs	370	740
2	Bolt & Nut	20pcs	7	140
3	Pulley	1pc	350	350
4	Bearing houses	4pcs	387.5	1550
5	Caster rollers	4pcs	65	260
6	Belt(BS3790)	1pc	70	70
7	Drum	1pc	440	440
8	Grinder disc	4pcs	35	140
9	Cutter disc	4pcs	35	140
10	Drill bits	8pcs	10	80
11	Hacksaw blades	10pcs	30	300
12	Anti-rust	1 liter	115	115
13	Brush 3”	3	10	30
14	Kerosene	1 liter	15	15
15	Sand paper	1 m	50	50
16	Metal paint	1 liter	130	130
17	Single phase electric motor	1pc	7,300	7,300
			Total cost	**11,850.00birr**

Cost of gear

Table 6.11 Cost of gear

No.	Item	Quantity	Unit cost	Total cost
1	Medium carbon steel	2pcs	147	294
2	HSS Cutter	2pcs	210	420
3	Machining by using lathe machine	12hrs	40	480
4	Cutting teeth on milling machine	6hrs	45	270
			Total cost	**1464.00**

Total cost

Table 6.12 Total cost

No	Item	Cost(Birr)
1	Cost of frame	1225.00
2	Cost of drum support/basement	1040.00
3	Cost of discharging lever	357.50
4	Cost of blade guiding shaft	330.00
5	Cost of u-channel	182.50
6	Cost of rotating handle	236.00
7	Cost of motor pulley	400.00
8	Cost of shafts	1592.00
9	Cost of tires connection	27.5
10	Cost of mixing blades	116.875
11	Cost of components bought from local market	11,850
12	Cost of gears	1464.00
Total Cost		**18,821.375**

Contingencies: - it is compensation due to some errors and unexpected failure of time in our project. It is usually taken as 10% of the manufacturing cost.

- Contingency = 10%×**18,821.375** Birr

$$= \frac{10}{100} \times 18{,}821.375 \text{ Birr}$$

Contingency = 1,882.1375 so that, overhead and labor cost is included or considered to be in contingency cost

- ***Total manufacturing cost*** = Manufacturing cost + Contingency

= 18,821.375 Birr + 1,8820.1375Birr

= **<u>20,703.5125 Birr</u>**

- ***Profit***: - it is usually taken as 20% of the total cost.

$$\text{Profit} = \frac{20}{100} \times 20{,}703.5125 \text{Birr}$$

⇒ Profit = 4,140.7025 Birr

- **Selling price** = Profit + Total manufacturing cost

= <u>4,140.7025+20,703.5125 Birr</u>

=**<u>24,844.215</u> Birr**

6.2 Maintenance of the machine

General considerations

Machines are subject to deterioration due to their longer service life and exposure to environmental conditions. Process of deterioration, if unchecked, culminates in rendering them unserviceable and brings them to a standstill. Therefore, it is necessary to attend to them from time to time, to repair and recondition them so as to elongate their life.

Inspection is an essential function of the maintenance program. There are external and internal inspections. External inspection means to watch for, and detect defects form abnormal sound, Vibration, heat, smoke etc. when machine is running; internal inspection means inspection of internal parts, such as gears, bushes, bearings, tolerances in the parts etc., during the period, when machine is under pre-planned shutdowns. Frequency of inspection should be decided very carefully, as too less inspection may cause break down, as defects could not be traced out and rectified immediately; while too much inspection means wastage of machine time and labor productivity. Hence frequency should be decided on the basis of past experiences and scheduled program for inspection.

Mechanical components like gears, bearings, bushings and other friction surfaces etc. give good performance for long periods, when they are systematically lubricated. Systematic lubrication means the application of right type of lubricant at the right time, at right place and in right quantity. For lubrication, a lubrication schedule should be prepared and that should be followed strictly.

Routine maintenance, like cleaning or lubrication, is required to ensure operation properly. The first maintenance activity for every workshop is cleaning. Cleaning is a prime activity in maintenance because cleaning removes the source of contaminations; flour dust, and dirty mixed with oil and grease. They can clog into machine parts and this accelerates wear and tear on the machine components and cause breakdowns.

Preventive maintenance activities of the Concrete Mixing machine

Table 6.13 Preventive maintenance activities

No.	Activities (detail of work)	Frequency	Estimated time	Comment
1	ELECTRICAL			
	Check operation of start/stop switch.	5 weeks	30 minutes	
2	MECHANICAL			
	Transmission gear check up	2 weeks	1hrs	
	Lubrication system check up for bearings	1 weeks	1hrs	
	Check up for belt tension	2weeks	20 minutes	
	check up for blades	1 week	1hr	
	check up for drum guiding rollers	2weeks	2hrs	
	check up for loosened bolts and nuts	4days	1hr	
	Checkup for pulleys	2weeks	20 minutes	

List of spare parts required for repairing

The principal spare parts that are required frequently to change when parts are worn out through long time performance are: bearings, belts, guiding rollers and blades. These parts can be easily manufactured to satisfy customer demand with respect to the entire machine.

SAFETY

Good slogan of safety states that “it is better to be safe than sorry!”

With respect to safety, everything has its own way of safe working condition. Therefore, the machine may cause injury, unexpected damage or strike to the human body if it is wrongly operated or safety consideration is poor. Among which the revolving belt may caught clothes, if something like tools or other materials were kept over the revolving part of the machine before start and unknowingly, these parts may be thrown and cause accident after the machine started running and etc. to avoid these and such;

- All necessary parts should be in place after use and in separate place far from the machine during the machine is running
- All bolts should be tightened.
- The output should always be in the down position. There is no reason why it should be in the upright position after mixing.
- Ensure that the motor throttle is set in its off position and it is recommended that the spark plug wire be disconnected and kept away from the spark plug.

Warning: Never start the machine if anything is kept inside the machine other than the necessary operation. This could result in injury or damage to the operator.

Working Principles

Starting and Running the Mixer

1) Ensure that all the mixer components are properly assembled and ready for operation.
2) Rotate the drum by hand to make sure that there are no restrictions to rotation.
3) Remember to tension the belt (the slack side of the belt) and make sure that the belt is seated properly in all pulleys and is not rubbing on anything.
4) Start the machine and observe the situation of the machine and if it is safe

start loading inputs of the concrete.

5) After proper mixing process push the discharging lever downward to unload the mixture all in all while the machine is running.
6) Release the discharging lever slowly until the machine returns its normal position.
7) Continue mixing by following the above steps but make sure that the drum is empty before loading the subsequent process.

Troubleshooting

I. Problem: Excessive vibration

Solution

- Check whether the drum is rotating over the roller or not.
- Check all bolts of bearing house are tightened.
- Check pulleys and belt system.

II. Problem: the pulley is not rotating

Solution

- Check the motor seat to properly fix at the right position in order to tight properly with pulley.
- Check whether the motor is rotating or not.

III. Problem: Belt deterioration or breaking prematurely(Check belt or pulley manufacture's catalog for full detailed list.)

Solution

- Check for foreign objects in the drive; make sure that the guard is installed.
- Check for oil or grease on belts. Clean belts and sheaves with a degreasing agent or detergent and water. Remove the source of oil or grease
- Re-tension the belt.

CHAPTER SEVEN
CONCLUSION AND RECOMMENDATION
7.1. Conclusion
The demand of this machine is higher and it is the time to respond for the concrete mixer workers' problem. It can solve the exhausting manual concrete processing tasks and saves time. It can also facilitate products with pure inputs without adding dusts or other foreign materials. This concrete mixer machine has two functions; namely, manual mixing in the absence of electricity and electrical or self rotating. Therefore the design best meets the country's demand in order to alleviate problems of heterogeneous concrete production specially using shovel to mix. Since the main function of this machine is to process concrete for construction industry workers it can facilitate productivity and it increases quality as well. One of the major problems in our country is ineffective use of resources that result in cracking of some part of building, cracking of parts of bridges and etc arise from improper mixing or producing of heterogeneous concrete. This is due to addition of dusts and foreign materials during mixing when it is used the oldest method in order to facilitate the production time faster.

The machine is tested for its functionality and in the first test of mixing, all the concrete inputs were loaded while the machine was running and discharged after proper mixing time and thus we got the machine is ready for the next batches except the speed was slightly higher than intended or required for proper mixing even if it is not exaggerated. Whatever the machine is technically feasible. Thus, the project is functional as per the design.

The machine can perform the following activities:

- ✓ Move from place to place easily by the help of tires attached to one side of the frame.
- ✓ Mix to the required ratio manually or electrically

This machine has also the following advantages:

- Manufactured from local materials
- Easy to assemble and disassemble.
- It does not need highly skilled manpower.
- Convenient for transportation.
- Low in cost and easy to maintain.
- Having two functions (manual and electrical) leads not to buy two different machines, this helps to save time and money.
- It can create job opportunity.

  It can be easily manufactured and distributed to various areas of our country and easily adapted as technology transfer to SMEs.

7.2. Recommendation

This small scale or mini concrete mixing machine is designed to optimize effective utilization of concrete and its constituents which are vastly wasted in rural areas where inputs are mixed manually using shovel in large volume without considering producing foreign material free concrete. Furthermore, the machine is proposed to produce in TVET and Small and micro Enterprises to duplicate for the concrete using community. Besides, this technology is believed to enhance and support medium level construction companies or contractors in producing quality concrete.

In addition to what had been indicated in this project work, we would like to recommend the following points:

- This design is a small scale, so it can be enlarged to increase its capacity or volume of production.
- This design can be changed by considering some practical aspects like using belt and pulley only without gear in order to ease production.
- When the power rating (kwh) of the machine is increased for large scale machines, the revolution per minute (rpm) also increases and hence, this maximizes the capacity of production. Therefore, we recommend large power ratings for larger machines.

- In towns, small and micro enterprises (SME) can manufacture and multiply the machines for construction sector to produce easily producible concrete.
- Rural and urban development experts at different levels can create awareness for easy dissemination of the technology in to rural areas because the machine was designed to work electrically and manually.
- Medium level construction contractors owning large capital can purchase and employ the machine while others can purchase in team to utilize the machine.

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APPENDIX A

Adama Science and Technology University

School of Mechanical and chemical Engineering

Department of Mechanical and Vehicle engineering

Questionnaire

Dear respondents: Concrete mixer is a machine used to mix aggregates, cements and water in order to provide concrete for construction and building industry. This is M.Sc thesis project questionnaire aimed at identifying the current concrete mixer problems in building and construction industry of the country.

So, you are kindly requested to fill the questionnaires as per the instruction given for each item. If you would like to change any of your response to a question, please do so by clearly crossing the incorrect response and making the response you intend. Note that:

- You are not required to write your name.
- Put (✔) mark in the box/cell for questions with options, and write briefly whenever necessary.
- You have to return the questionnaire to the person from which you received as soon as possible after completion.

Thank you!!!

Part I. Tick (√ or x) in the given box.

በሚስማማዎት ሳጥን ዉስጥ የ(✓) ምልክት ያስቀምጡ!

I. Personal characteristics
የግል መረጃ

1. Sex: Male ☐ Female ☐
ፆታ፡ ወንድ ሴት

2. Age: 15 -20 ☐ 21 – 30 ☐ 31 – 40 ☐ Above 40 ☐
እድሜ

1. Educational qualification level:
የትምህርት ደረጃ

- Under graduate (Degree) ☐ Diploma ☐
ድግሪ ድፕሎማ

- Postgraduate (Master) ☐ Certificate ☐ By experience ☐
ማስተርስ ሰርቴፊኬት በልምድ

Part-1

I. Use a tick mark (✔) in the cell corresponding to your answer.

ለመልሶችዎ በሚመጥን ሳጥን ዉስጥ የ(✔) ምልክት ያስቀምጡ!

No. ተ.ቁ	Items ጥያቄ	Yes አዎ	No አይደለም
1	Have you ever bought concrete mixing machines? ካሁን በፊት የማቀላቀያ ማሽን ገዝተዉ ያዉቃሉ?		
2	At this time, is there a need of concrete processing machine in the market? በዚህ ጊዜ የማቀላቀያ ማሽን ፍለጎት አለ?		
3	Are you interested to buy if concrete mixing machine can be made at Adama Science and Technology University with reasonable price? በአዳማ ሳይንስና ቴክኖሎጂ ዩኒቨርሲቲ የማቀላቀያ ማሽን በተመጣጣኝ ዋጋ ቢመረት የመግት ፍላጎት ይኖርዎታል?		
4	Are the concrete mixers you are working with are only electrically powered? የሚጠቀሙበት የማቀላቀያ ማሽን በኤሌክትሪክ ኃይል ብቻ የሚሰራ ነዉ?		
5	Are there different concrete mixing machines in the market that help to increase quality of concrete product? ጥራት ያላቸዉ የተለያዩ የማቡኪያ ማሽኖች በገበያ ላይ አሉ?		
6	Have you worked with manually operated mixer machine? በእጅ በሚሰራ የስሚንቶ ማቡኪያ ማሽን ሰርተዉ ያዉቃሉ?		
7	Are the machines easily maintainable? የሚገለገሉበት ማሽን በቀላሉ የሚጠገን ነዉ ወይ?		
8	Do you know as there is a different type of mixer machines? የተለያየ ዓይነት የሲሚንቶ ማቡኪያ ማሽን እንዳለ ያዉቃሉ?		
9	Do the machines come with spare parts? የሚጠቀሙት የማቡኪያ ማሽን የመጣዉ ከተለዋጭ አካል ጋር ነዉ?		
10	Is there possibility of moving machines from place to place easily without the help of trucks? የሚሰሩበትን ማሽን መኪና ወይም ሌላ የክብደት ማንሻ መሳሪያ ሳይጠቀሙ በቀላሉ ከቦታ ቦታ ማንቀሳቀስ ይችላሉ?		

Part II

1. Where the machines you are using do made in? ___________________________

   የሚገለገሉበት ማሽን የየት ሀገር ስሪት ነዉ?

2. How do you feel if manually operated concrete mixing machine is designed and produced to have an alternative where there is no/interruption of electricity?

   መብራት በለሌ ጊዜ ሊያገለግል የሚችል አማራጭ የማቡኪያ ማሽን ቢሰራ ምን ይሰማዎታል ወይም እንዴት ያዩታል?

   ____

   ____

3. Who control the maintenance activity of the machine?

   የማሽኑን ጥገና አስመልክቶ በስራዎ አካባቢ የሚቆጣጠረዉ ሰዉ ማን ነዉ?

   ____

4. Is there problems related to concrete mixing machine you faced?

   ከሚገለገሉበት ማቡኪያ መሳሪያ ጋር ተያይዞ ያጋጠመዎት ችግር አለ? -

   ____

If your answer for question number 5 is “yes”, list some of them. ____
____
__________.

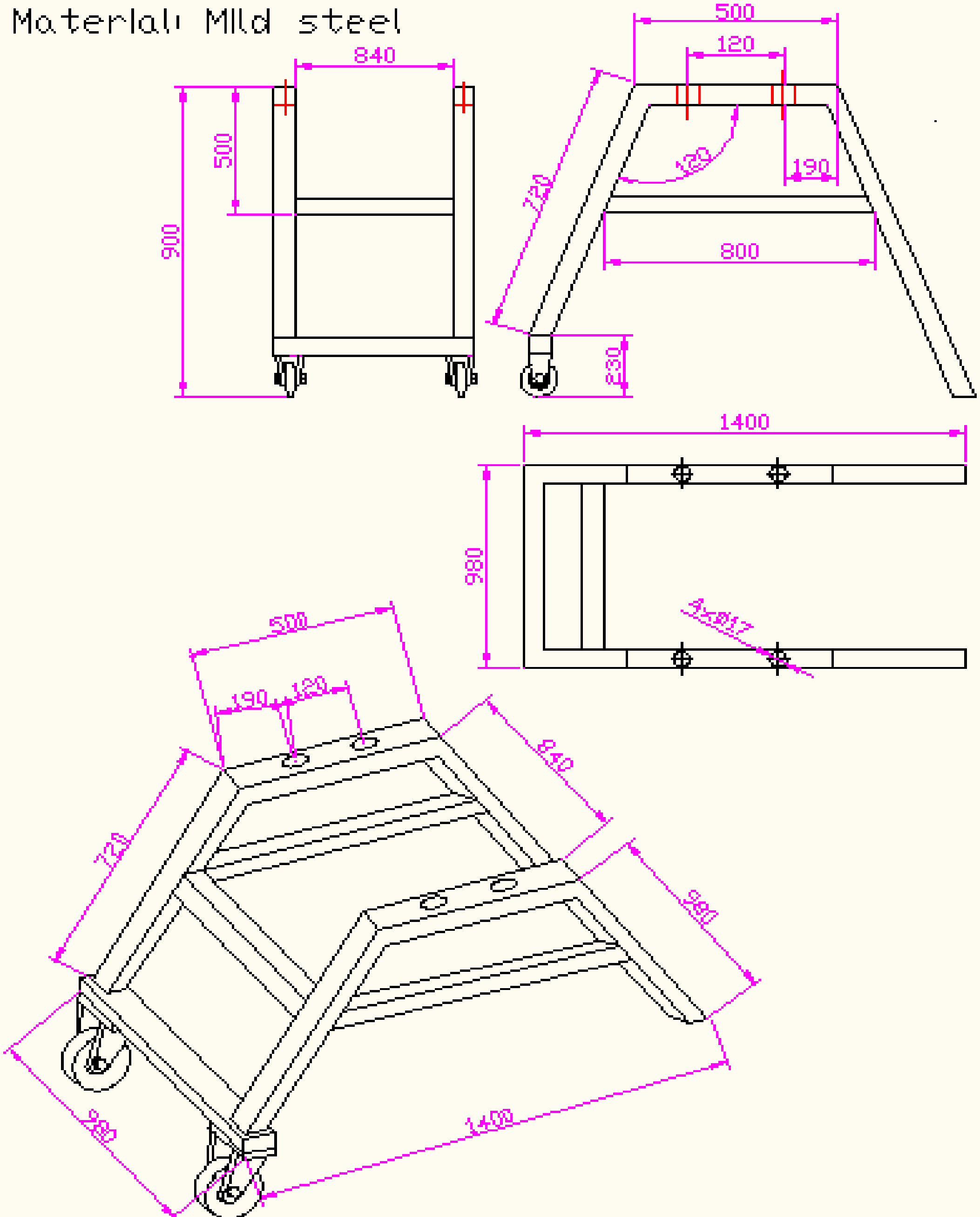
Thank You!

Appendix B

Detail drawings

RevNo	Revision note	Date	Signature	Checked

Material: Mild steel



Itemref	Quantity	Title/Name, designation, material, dimension etc	Article No./Reference

Designed by	Checked by	Approved by - date	File name	Date	Scale
GEMTA	DAGMAWI	DR.HABTAMU	1	24/04/2015	1:1

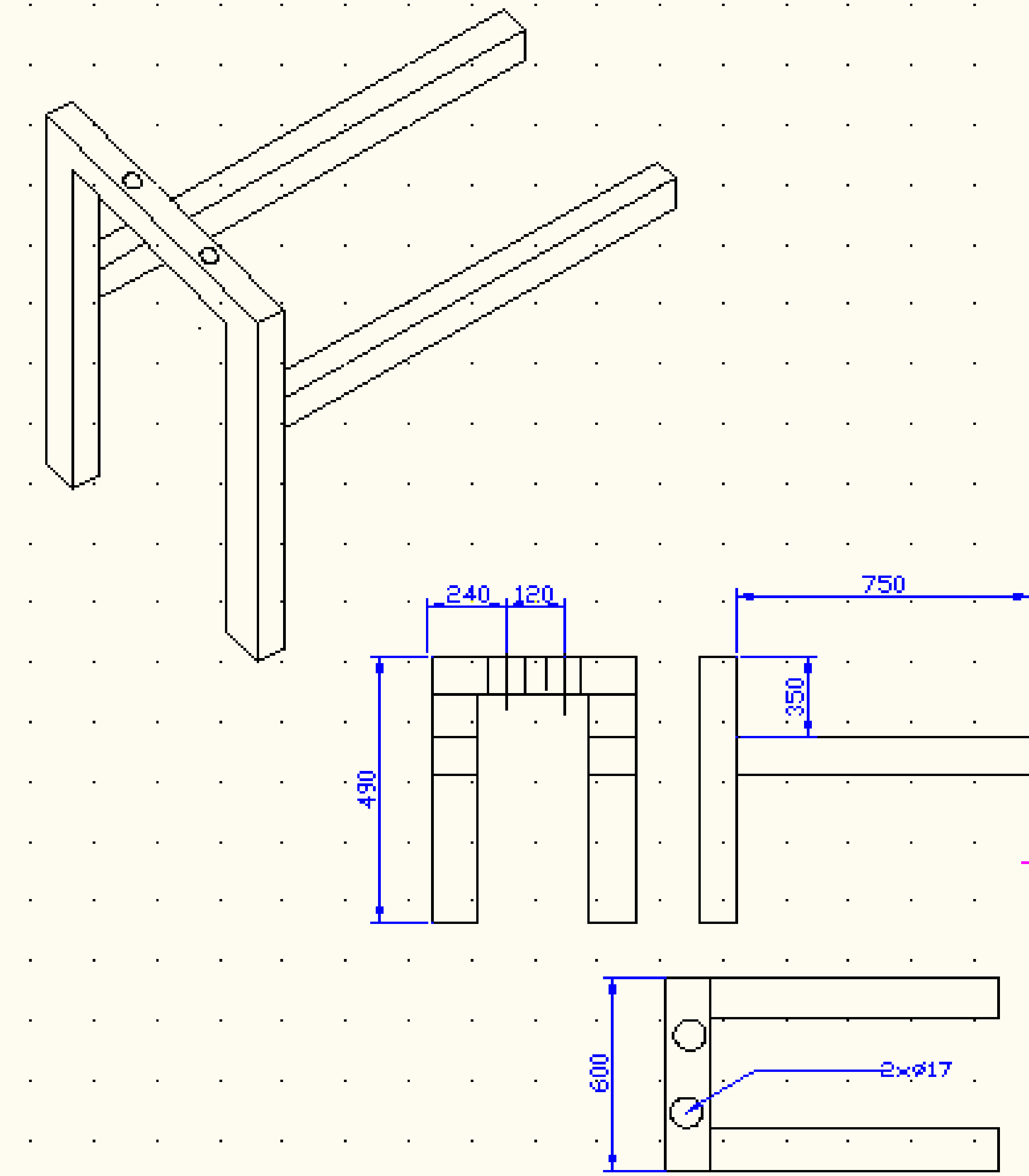
Adama Science and Technology University

TITLE Stand of the machine

DRAWING_NUMBER_01	Edition	Sheet
	01	01

RevNo	Revision note	Date	Signature	Checked

Material: 40x40 sqr. pipe(Steel)
Quantity: 01



Itemref	Quantity	Title/Name, designation, material, dimension etc	Article No./Reference

Designed by	Checked by	Approved by - date	File name	Date	Scale
GEMTA	DAGMAWI	DR.HABTAMU	2	24/04/2015	1:1

Adama Science and Technology University

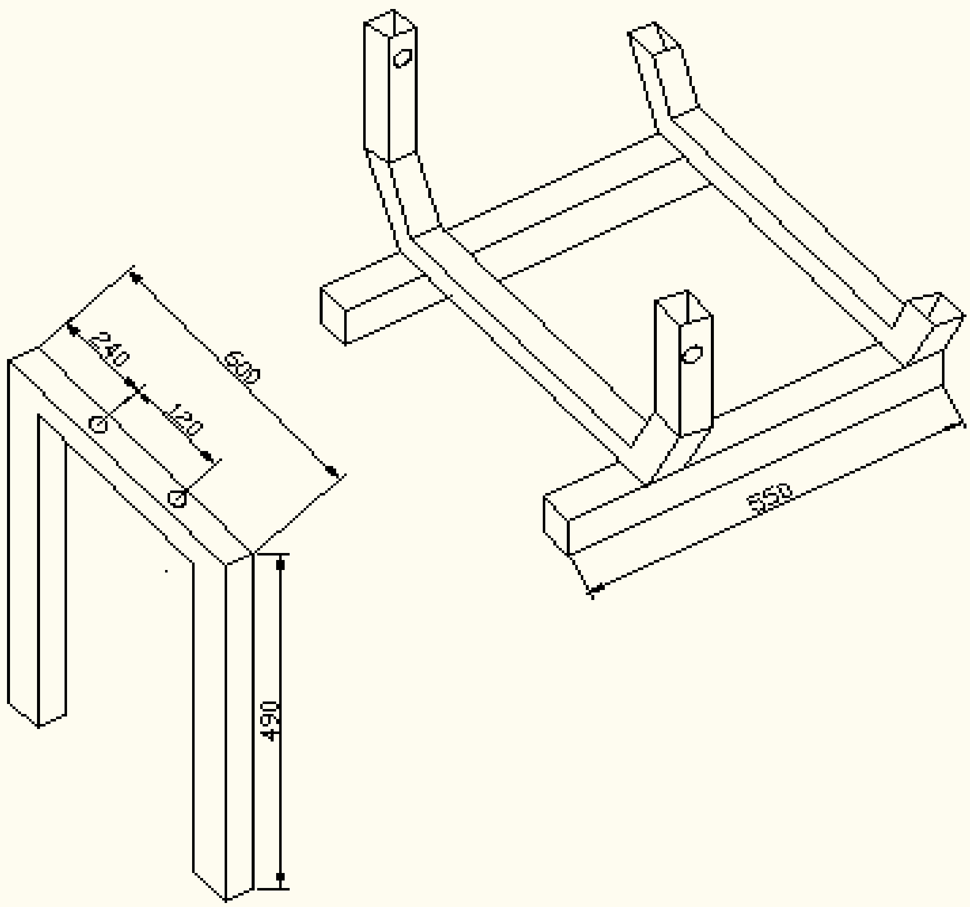
TITLE support of the barrel

DRAWING_NUMBER_02

Edition	Sheet
01	02

RevNo	Revision note	Date	Signature	Checked

Material: 40x40 sqr. pipe(Steel)
Quantity: 01

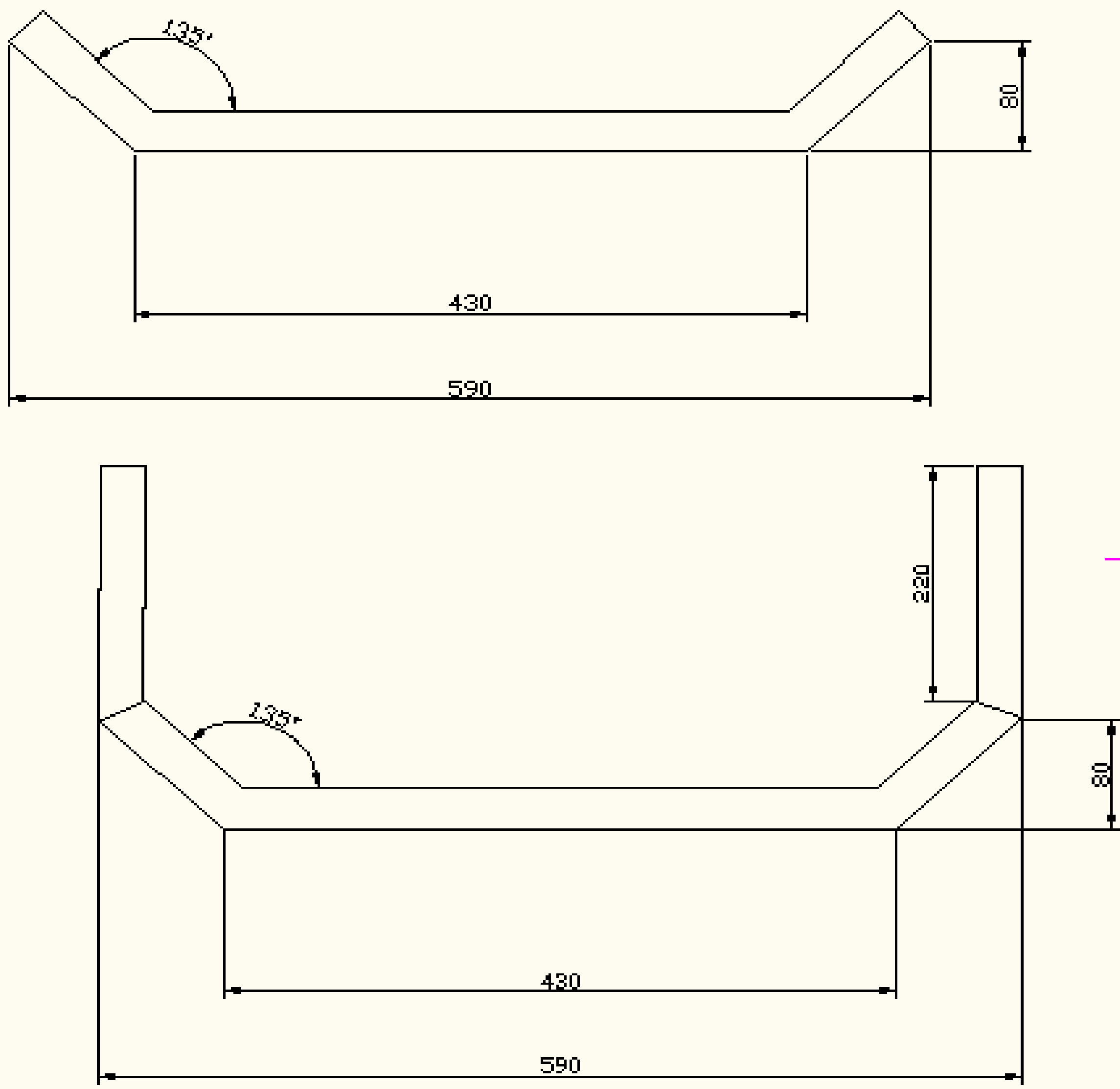


Itemref	Quantity	Title/Name, designation, material, dimension etc		Article No./Reference	
Designed by GEMTA	Checked by DAGMAWI	Approved by – date DR.HABTAMU	File name 3	Date 24/04/2015	Scale 1:1

Adama Science and Technology University	TITLE Part of support of the barrel		
	DRAWING_NUMBER_03	Edition 01	Sheet 03

RevNo	Revision note	Date	Signature	Checked

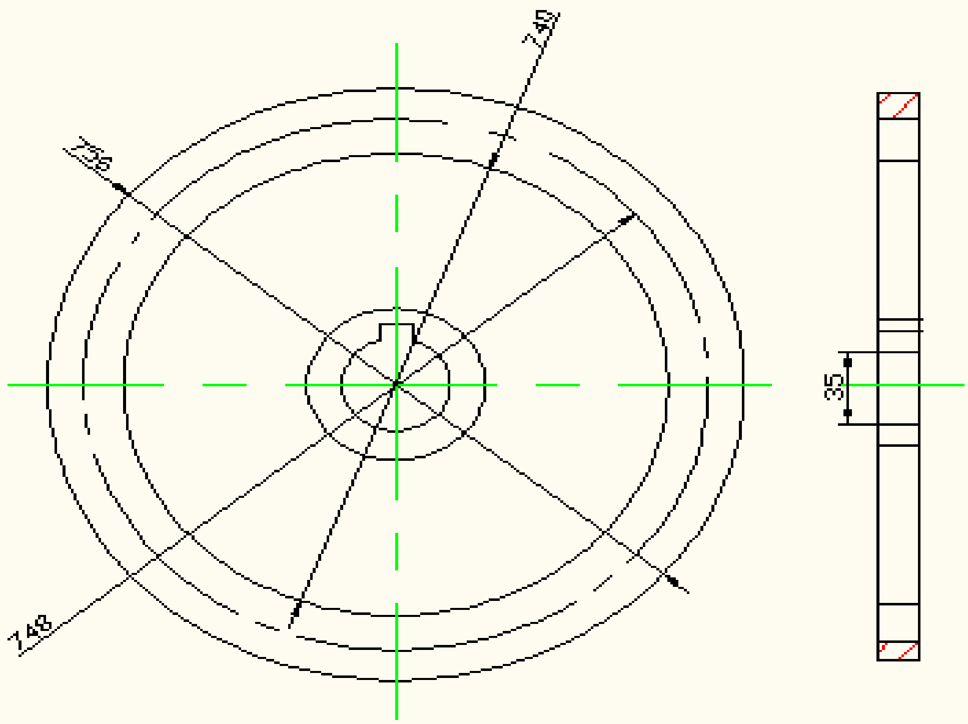
Material: 30x30 Steel Pipe
Quantity: 01



Itemref	Quantity	Title/Name, designation, material, dimension etc			Article No./Reference
Designed by GEMTA	Checked by DR.HABTAMU	Approved by - date DR.HABTAMU	File name 4	Date 24/04/2015	Scale 1:1

Adama Science and Technology University	TITLE Front support of Barrel		
	DRAWING_NUMBER_04	Edition 01	Sheet 04

RevNo	Revision note	Date	Signature	Checked



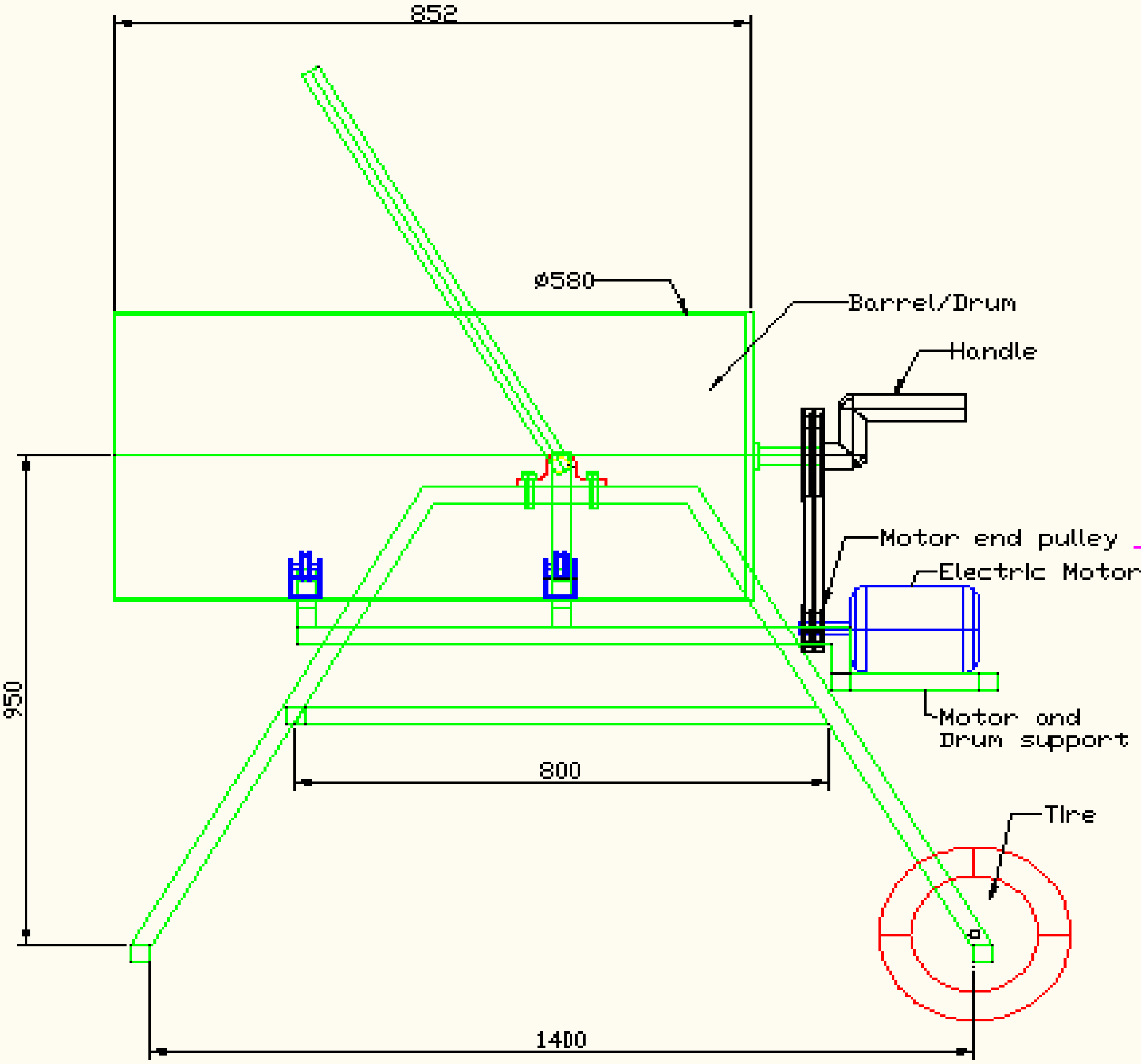
Itemref	Quantity	Title/Name, designation, material, dimension etc	Article No./Reference

Designed by	Checked by	Approved by - date	File name	Date	Scale
GEMTA	DAGMAWI	DR.HABTAMU	5	24/04/2015	1:1

Adama Science and Technology University	TITLE Spur Gear		
	DRAWING_NUMBER_05	Edition 01	Sheet 05

RevNo	Revision note		Date	Signature	Checked

Material: Steel
Quantity: 01



Itemref	Quantity	Title/Name, designation, material, dimension etc		Article No./Reference	
Designed by GEMTA	Checked by DR.HABTAMU	Approved by - date DR.HABTAMU	File name 6	Date 24/04/2015	Scale 1:1

Adama Science and Technology University

TITLE Front of the Machine

DRAWING_NUMBER_06	Edition 01	Sheet 06

Appendix C

Standard bearing house

HOUSING NUMBER	SHAFT DIA			D	a	b	c	g H12	h js11	L	w	m	S Bolt	U	V	d2 H12	d3 H12	f1
	mm	Inches																
SNG 507-606	30	$1\frac{1}{8}$	$1\frac{3}{16}$	72	185	52	22	34	50	82	92	150	M12	15	20	46.5	54.5	5
SNG 508-607	35	$1\frac{5}{16}$	$1\frac{3}{8}$	80	205	60	25	39	60	85	106	170	M12	15	20	51.5	59.5	5
SNG 509	40	$1\frac{1}{2}$	$1\frac{9}{16}$	85	205	60	25	30	60	85	109	170	M12	15	20	56.5	64.5	5
SNG 510-608	45	$1\frac{11}{16}$	$1\frac{3}{4}$	90	205	60	25	41	60	90	112	170	M12	15	20	62	70.5	5
SNG 511-609	50	$1\frac{15}{16}$	2	100	255	70	28	44	70	95	127	210	M16	18	23	67	75.5	5