CHAPTER TWO

2.0 LITERATURE REVIEW

At a very early stage man released that the means of moving thing about which nature had provided him left much to be desired. He is severally limited in loads; he carries the area he could carry them and the speed at which he could travel. One is right to guess that the physical exertion involved was no more to his liking them, than it is today.

Man started by mean of training suitable animals to enable heavier loads to be carried at far distance, and at high speed than he was capable of attaining and there was an added advantage than most of the effort was provided by animal, while the man could at ease.

Heavy loads were dragged upon sledges until an early and unknown engineer invented the standard barrow. This was made possible because construction material was made of wood upon which heavier loads could be carried more easily.

The draw back to the use of this type of standard wheelbarrow was that it could not carry much heavy loads because of the strength of the materials in which it was made of. The wheelbarrow can't absorb shock, which may probably damage some perishable/breakable good s loaded on it. Above all, it cannot move on the road that is not smooth and hard.

As new materials and manufacturing methods were developed it became possible to improve in standard wheel barrow that are new made up of materials that can withstand shock, carry heavier loads, more in any type of road and above all, have to withstand load.

Other types of wheel activities that can carry load were also developed such as stream engines, electric card and internal combustion engines.

2.1 HISTORICAL REVIEW OF WHEELBARROW

The origin and development of the wheel holds an important place in the history of invention because it's clearly illustrates a phenomenon known as independents invention. Thus, the wheelbarrow has more than a single source of origin and was developed for different purposes.

The earliest form of wheelbarrow was developed in China shortly before AD200, and traditionally its design is attributed to a general in the imperial any, although these probably mere folktale. The map of the Chinese wheelbarrow alone is enough to suggest how it originates. The single wheel is large, often three or four fat in diameter and usually has a dozen or more spokes. It is set between the shafts at a considerable distance from the front end of the barrow, while a boxing or wooden frame is built up from the shaft to encase the upper half of the wheel. Platforms projected from the shaft on both sides. The goods to be carried are loaded on these platforms and on the upper surface of the boxing. If the burden are correctly placed not only would its weight balance on both sides of the wheelbarrow but it would also before and after the axle of the wheel. The weight of the load is barrow could use his energy solely for moving it and maintaining its balance.

This kind of barrow appears to have been developed from two-wheeled handcarts on which, with modification, the pair of wheel. In many parts of China, especially in the wet, rice growing area, field boundaries are often no more than narrow embarkment, the tops of which must also serve as paths.

This wheelbarrow, therefore seems to be an adoption of the hand cart designed to allow it to move along narrow paths. Indeed, early illustration of Chinese wheelbarrows and forward placing apart from pushing and balancing has to lift a large part of the burden. It was totally unsuitable for shifting goods over long distances.

This until the seventeenth century, when direct contact were made between Europe and China, as a result of trade, each area had its own distinct form of wheelbarrow, although by this time both were frequently modified to serve other needs than those for which they were designed.

2.2 THEORY & WHEELBARROW MECHANISM OF OPERATION OF

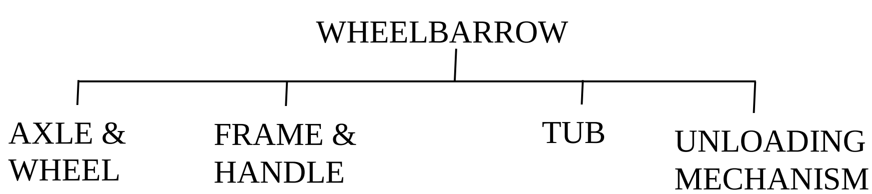
Wheelbarrows are artificial tools in the fields of construction, landscaping, home improvement, and gardening. Most wheelbarrows are designed around the idea of toppling the wheelbarrow over or strenuously lifting the handless to unload it and are typically equipped with a single wheel in front. While this is a simple concept, it can lead to out of control loads and accidental spills. Aspect Engineering designed a new wheelbarrow with the goals of providing the stability, loading capacity, and ease of use that typical wheelbarrows fall to provide. The "Rolling Barrel" has half of a 55 gallon derum mainted on a frame to hold the transportable contents, which can then be related about its center of mass to unload it.

The typical wheelbarrow design has accomplished the ability to transport a large amount of cargo safely and efficiently with some success, but with enough creative engineering and consideration, this concept can be improved. The capabilities of this basic wheelbarrow can be largely surpassed when the bar is raised to new capacities and functionality.

But problems may arise when the wheelbarrow is loaded heavily. The user must lift the handle to rotate the load about an axis far from the load's center of mass. At times, this means the wheelbarrow cannot be unloaded with a single a single wheel for support while transporting contents. The wheelbarrow can easily tip over, especially when the wheelbarrow is heavily evaded to one side, or being rolled across a slope. This can usually be attributed to a high centre of gravity, inadequate lateral supports, and the inability of the wheelbarrow to adjust for such conditions.

DESIGN PARTITION

A junction tree was designed to break up all possible concepts into the required subsystems. This was done to ensure that all aspects of the wheelbarrow are taken into consideration and to ease the design process. The tree show the wheelbarrow subsystems: a tub to contain the materials to be moved, a frame and handles to support and maneuver the tub, an unloading mechanism for removing the materials from the tub, and the wheels and axle to move the materials.



CONCEPTUAL IDEAS

The first two ideas are simple additions to the basic wheelbarrow design. The "pump and dump" design is based on the basic wheelbarrow, but instead of lifting the load by the handles, the operator steps on a lever that flips the load over the front wheel.

The "Adjustable Handle" design is also based on the basic wheelbarrow, but the handle used to move and lift the load can slide up and down for increased leverage while unloading and allows the operator to life using leg muscles rather than back muscles.

The "Splitting Barrel" design has a drum that separates along the bottom to allow the load to fall through to the ground, thereby using the stored potential emery to unload the contents. The operator simply unlatches the barrel quarters from each other at the bottom.

The "Rolling Barrel" design has a drum that is rotated about its center of mass by way of a handle or crank. The barrel is unloaded by applying a small force to rotate it upside down, thereby allowing the stored potential energy to unload the contents.

The final concept is much like a box on wheels. "Old N0.5 has a door on the front that opens, and a mechanism to push/pull the 1contents through the door.

ENGINEERING ANALYSIS

There are two main objectives in these engineering analyses. First, the device must not fail unclear heavy loading therefore, the maximum stress and deflection produced in the cross beam of the wheelbarrow from the load of the drum was investigated. Second, the forces required to unload the wheelbarrow were investigated. The analysis of the crossbeam is presented first.

First a maximum load was defined to be sand that would fill up the barrow and also be heaped above. The volume of sand would approximately be 55 gallons. The density of sand is 2,300kg/m^3. So, the total weight of the sand is 1060 pounds. With two cross beams this weight is divided between the two making the force on one crossbeam 530 pounds.

Next, the maximum value of the moment in the crossbeam was found. The force and moments acting on the crossbeam were defined as a downward force at the center of the beam, and an upward force as well as moment acting on both ends of the beam.

From beam analysis the maximum moment was determined to be:

$$M = \frac{3PL}{8} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where P is the downward force acting on the center, and L is the length of crossbeam.

The maximum stress occurring in the beam was found from the moment and is:

$$\sigma = \frac{3Plh}{16L} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

In the equation h is the height of the beam and I is the moment of inertia of the beam.

The maximum deflection of the beam occurs at the center. It is related to the downward force by equation 3.

$$\sigma max = \frac{5PL}{192El} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Young's modules are represented by the variable E. For a solid beam the moment of inertia is given by:

$$I = \frac{bh^3}{12} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

For a hollow beam the moment of inertia is:

$$I = \frac{bh^3 - (b - 2t)\,(h - 2t)^3}{12} \quad \ldots\ldots\ldots\ldots (5)$$

In both moment of inertia equations, **b** is the width of the crossbeam and **t** is the inner thickness for the hollow beam.

For a 2"x2"x28" steel beam the maximum stress is 4ksi. This stress is well below the yield strength of steel of 36ksi with a safety factor of 9. Also, the downward deflection of the beam at the centre is 0.0078". In a hollow steel beam of the same dimensions with an inner thickness of 0.125" the maximum stress is 10ksi. The safety factor for the hollow beam is 3.6. The deflection at the center is 0.019".

Next, the analysis of the force required to turn the barrel is presented. This analysis is performed for two different designs the first is a simple handle design the second is a gear design.

The handle design consists of a barrel with a simple handle to related the barrel. The distance from the axis of mation to the handle is the same as the radius of the barrel, or half of the with, **W**.

The force required to pivot the barrel is called **Fn** the gear design consists of the barrel with one large gear mounted on the axis of rotation and a smaller gear with a handle.

The force required to rotate the barrel is called **fg**. The ration of the larger gear diameter to the smaller gear is called r. the handle length is **Ln**.

By summing the moments about the axis of rotation, the following relationship between the over all torque, **T**, required to rotate the barrel and the force, **Fn** for the handle design is derived.

$$T = Fn \frac{w}{2} \quad \text{………………. (6)}$$

For the Gear Design, the overall torque, T is a function of the gear ratio, handle length and force, Fg.

$$T = Ln\, Fg \quad \text{………………. (7)}$$

By combining equations 6 and 7, a ration of the forces for the two designs indicates the mechanical advantage of the Gear Design over the Handle Design.

$$\frac{Fg}{Fn} = \frac{W}{2rLn} \quad \text{………………. (8)}$$

The distance from the center of mass to the axis of rotation is called **d**.

$$d = \frac{2W}{3n} \quad \text{………………. (9)}$$

Again, **W** is the width of the barrel so, by summing the moments about the axis of rotation, the static torque, Ts, is a function of G & d.

$$Ts = Gd \quad \text{…………………. (10)}$$

Where **G** is the gravitational force acting on the center of mass of the barrel (including the load).

Substituting for G with product of the density of the medium inside the barrel, p, the volume of the barrel, **v**, and the acceleration due to gravity, g, equation 10 becomes:

$$Ts = pVgd$$

Substituting for the volume with the length, L, and width of the barrel, W, equation 5 becomes

$$Ts = \frac{W^3 Lpg}{12}$$

Next, the dynamic torque required to rotate the barrel was investigated. Neglecting all friction, the dynamic torque to rotate the barrel, Td, is a function of the angular acceleration, x, and the mass moment of inertia of the load in the barrel, J.

$$Td = J\alpha \text{ ……………………………} (11)$$

The mass moment of inertia, J, as a function of the density of the medium in the barrel, P, and the dimensions of the barrel, L and W.

$$J = \frac{PLW^4\pi}{64} \text{ ………………………... } (12)$$

2.3 WHEELBARROW AND OTHER CLASSES OF LEVER

The Lever

The simplest machine, and perhaps the one with which we are most familiar, is the lever. A seesaw is a familiar example of a lever in which one weight balances on the other. You will find that all levers have three basic parts: the fulcrum, F, a force or effort, E, and a resistance, R

First Class Levers:

In the first class lever, the fulcrum is located between the effort and resistance. As mentioned earlier, the seesaw is a good example of a first class lever. The amount of weight and the distance from the fulcrum can be varied to suit the need. An oar is another goal example. The ocerlock is the fulcrum, and the water is the resistance. In this case, the force is applied one side of the fulcrum and the resistance to be overcame is applied to the opposite side; this is a first class lever. Crowbars shears, and pliers are common examples of this class of leavers.

Second Class Levers:

The second-class lever has the fulcrum at one end, the effect applied at the other end and the resistance somewhere between these points. A wheelbarrow is a good example of a second-class lever. If you apply 50 pounds of effort to the handles of a wheelbarrow 4 feet from the fulcrum (wheel), you can lift 200 ponds of weighed 1 foot from the fulcrum. If the load were placed further away from the wheel, would it be easier or harder of lift? Levers of the first and second class are commonly used to help in overcoming big resistances with a relatively small effort.

Third class levers:

Sometimes you will want to speed up the movement of the resistance even though you have to use a large amount of effort levers that help you accomplish there are in the third class of levers.

2.4 USES/IMPORTANCE OF WHEELBARROW

The uses and importance of a wheel barrows are numerous and cannot be over emphasized. It is used in various aspects of work and they are as follows:

a. It is used in the farm to transport farm implements from one place to another, transporting weeds or residues that are to be disposed of their incarnation points; and for short distance, for moving the farm produce to the point they are needed.

b. It is also used in the workshop for moving materials for any purpose from one points to another.

c. It helps reduce the work of man i.e. it helps man to move things around easily.

2.5 MATERIAL SELECTION/MATERIAL OF CONSTRUCTION

This is mostly affected by the non-accountability of suitable materials that would have been best suited for some specific parts, so the material of construction was given serious consideration of the standard wheelbarrow. The materials to be considered for any of the component manufacturer, must have the relative property usefulness and appropriate for the function of that component parts.

Handle cover: It is made of elastic rubber, in order to avoid friction and bruise of the palm.

Stands: Mild steel bar is used in the construction of bowel support bar. The material is chosen because of its relative cheapness, availability. Some other materials like aluminum, cost iron and stainless steel but because of their high cost of production and processing, mild steel is chosen, not minding the other materials; though stainless steel is better because of its ability to withstand corrosion and good finish.

Handle or frame: Steel pipe is normally used because of its corrosion resistance and its light weight.

Wheel: This material is used because of its relative cheapness, it is easily sheared or cut and above all its resistance to corrosion (carbon steel sheet and mild steel).

Bowel: Cudvconised caamon steel is used because it is easy to cut and relatively cheap and resistant to corrosion.

Spindle or shaft: Mild steel is used to construct the spindle as a result of its relative cheapness and easy machinable property.

Ball bearing: There are two in number and are made of sintered metal because it can easily be rolled into balls due to its ductility.