DEVELOPMENT OF A MECHANIZED FEEDING SYSTEM FOR PIGGERY

BY

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CERTIFICATION

This is to certify that this work on the development of a mechanized feeding system for piggery was presented by *Daniel Patience Ijeoma* of the Department of Agricultural Engineering, School of Engineering and Engineering Technology, University of Technology, Minna, in partial fulfillment of the requirement for the award of the Degree of Bachelor of Engineering in Agricultural Engineering.

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DEDICATION

This project work is dedicated to my darling husband, MR FRANCIS IHEKWEABA, the only man I can ever love.

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I wish to express my sincere gratitude unto the ALMIGHTY GOD for seeing me through my academic pursuit. I must confess that if not for the LORD, I wouldn't have gotten this far, To Him be the glory for all things he has done for me.

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Daniel P. I.

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ABSTRACT

The work reported here presents the development of a mechanised feeding system which is intended to reduce the high labour demand involved in the manual feeding of pigs.

It employs the principle of a belt conveyor which is powered by a 2hp electric motor and fed from a hopper mounted above the belt conveyor As the conveyor travels, it carries the feed and discharges it at each of the pens sequentially.

The design has a capacity of handling 666.67kg of feed and the feeding time per each feeding is four hours which is just 8% of the time required to feed the same number of pigs using manual labour.

The system is designed for 1000 pigs of grower stage.

CHAPTER ONE

INTRODUCTION

Pigs are prolific animals [producing much or many] which are primarily kept all over the world for the production of meat including pork, bacon or fat. An advantage of pig farming that is now becoming apparent in some tropical countries is now becoming apparent in some tropical countries is its growth rate. Pig production can yield a relatively rapid return on the capital employed. They have a fast growth rate and reaches sexual maturity within 5-7 months. They commonly farrow 6 to 13 piglets per litter and can produce two litters in two years. in one year or five litters in two years. These factors together provides a rapid a rapid return on capital invested in pig farming [Akinyosoye, 1976].

Other advantages of pig raising include:

1.1 SOIL FERTILITY IMPROVEMENT

Like other farm animals, pig contribute a considerable amount of fertilizing to the soil through their manure. A mature pig can produce 600-730kg of manure annually [Eusebio,1980].

With the prevailing problems in the provision of inorganic fertilizer, organic fertilizer from the manure of farm animals will help supply some of the soil nutrients required by plants especially vegetables. In some sugar producing countries, pig manures are drained from big piggeries into irrigation canals which irrigate the sugarcane fields [Eusebio,1980].

1.2 LARGE LITTERS

Eusebio [1980] highlighted that a sow can easily produce a litter of 8 to 12 pigs after a relatively short gestation period of 112-120 days. In many undeveloped tropical countries in which pork consumption is not restricted by religious customs and beliefs. Pig raising can be a substitute to supplement the production of protein food for the rapid rate of population increase.

1.3 EFFICIENT CONVERSION OF ANIMAL FEED TO HUMAN FOOD.

In terms of efficient production of meat, the pig is superior to beef cattle, goats or sheep when the feed provided is of a high quality. When the feed is of lower quality e.g. rice born, grass, hay etc, the pig is not as efficient as ruminant livestock,

1.4 TOLERANT TO A WIDE VARIETY OF FEEDS

Pigs of all classes except young piglets, can tolerate all kinds of feeds even to some extent low quality, highly fibrous foods. It has been a practice in developed and under developed countries engaged in pig production to feed pregnant sows with freshly cut forage or corn soilage mixed with a small amount of protein feed concentrate. This reduces energy intake, economically and improves the sows reproductive efficiency [Eusebio,1980].

1.5 SPACE REQUIREMENTS

As recorded by Eusebio, (1980),pigs need only a small space in which to grow unlike beef and dairy cattle which usually require at least one hectare of natural pasture per hectare, pigs can be raised on a small area either in close confinement within a building or on a small area of pasture. Even suburban area, pigs are raised either in the backyard with 1-3 heads per family or in a medium production scale with an average of 20-50 heads per family. A mature sow or active boar requires only 4-5m^2 of living space [Eusebio,1980].

1.6 PROFITABLE FOR SMALL FARMERS

Many poor families in rural areas in the less developed tropical countries of south east Asia and south America, raise one or two pigs as their banks. These families schedule the raising of their pigs so that they sell them at the beginning of the school year when they have to pay the school fees for their children (Eusebio, 1980). The poor families in the suburban or rural areas find raising one or two pigs in their backyard profitable since the feed used usually comes from left overs in the kitchen and from the farm.

Pig keeping has many advantages as studies have revealed that pigs are prolific animals which require high quality well balanced feed and careful management to perform optimally (Eusebio, 1980). Investigation from pig farmer in Nigeria have revealed that feeding of the pigs has always been their problems since the labour cost is high and allowing them to scavenge for food neither increased their production efficiency nor enhance their Production capacity or yield. (Research finding). They can not adopt the already existing mechanized system of feeding as is been practiced in developed countries because of the cost. All these make pig keeping in Nigeria unprofitable unrewarding and a boredom business or venture.

It is as a result of this problem that most of the pig farmers in both urban and rural areas allow their pigs to roam about without control. Several problems are associated with this practice. Not only do the pigs constitute a problem to other farm produce (i.e. destroying other crops) but their growth rate and performance cannot be measured scientifically. It is thus desirable to have a confined environment for this pigs so that

The entire production process can be effectively controlled. since the feeding operation is one of the most tasking in the entire production process, it is thus necessary to mechanize such system so as eliminate or minimize the labour and its cost.

OBJECTIVE

The broad objective of this project is to develop a mechanized feeding system for pig production, that will reduce production cost.

The specific objective are

(1) To provide hygienic feeding

(2) To reduce labour and its cost

(3) To enhance overall production through quality and quantity improvement

JUSTIFICATION

The term mechanization can generally be defined as the use of hand and animal operated tools and implements as well as motorized equipment to reduce human effort, improved the timeliness and quality of various farm operation and thereby increase yields, quality of products and overall efficiency [CULPIN, 1981].

As recorded by Culpin(1975), mechanization was earlier concerned mainly with the application of mechanized power to field operations but that by 1950 , this had reach a high level of development as attention was increasingly turn to mechanization of work in and about the farm building mainly in livestock tending.

The main objective of adopting mechanization in the feeding of farm animals is to reduce labour cost and time involved in the manual feeding of these animals[CULPIN, 1981]. It has been revealed from literature that there may ways in which the objectives have been achieved depending on the type of animal in question.

In Nigeria hitherto, it could be seen that big farmers still feeds their animals manually, thus making the business boredom one. It is the desire of any farmer to have the maximum profit from his/her enterprise. This can be achieved through minimizing the cost of production. The business of pig farming is very lucrative one if managed properly. It is thus desirable to improve the production of pigs through mechanization of the labour intensive and time consuming exercise of feeding in Nigeria putting cost of system into consideration. This will help in increasing the production efficiency of the animals, enhance their production capacity and save labour cost and time that can be utilized for other economic production.

Provision of such system will also eradicate the practice of leaving the pigs to roam about to scavenge for food thereby constituting further problems to other crops and people alike.

CHAPTER TWO

2.0 LITERATURE REVIEW

The following is a general description of the common breeds which are regarded by pig farmers

2.1.1 LARGE WHITE OR YORKSHIRE

This is one of the most widely important breed found in many parts of tropical Africa and is particularly common in the west Africa. It is an English breed used mainly for the production of bacon but is adaptable to a wide range of climatic conditions. The skin is white and the animal has erect ears. According to Akinyosoye (1976), this breed has a high reputation as a prolific breeder. The female produce large quantity of milk, have a large number of teats and are regard as being excellent mothers. It is an efficient food converter with a good growth rate, although somehow slow in reaching maturity. They are mainly used for pork in west Africa and also widely used in cross breeding program (Akinyosoye, 1976).

2.1.2 LARGE BLACK

This is another English breed which is for the production of pork and bacon but it is not as important as the large white among west African pig farmers. It is a solid black pig with a fairly long body and good body size. The female have a good mothering ability, but this is less developed than in the large white (Akinyosoye, 1976).

2.1.3 DUROC

This is an American breed use mainly for pork production and originated from New York state. The large body produces a good quality of flesh but the females have fairly poor mothering ability. (Akinyosoye, 1976).

2.1.4 WEST AFRICAN DWARF

West African breeds are small compared to imported breeds. Although they have similar physical feature, they are poor producers, slow maturing and have a poor growth rate. They are however good converter of kitchen waste and have good mothering abilities. They are reared locally and are not normally given any proper housing, feeding or sanitary facilities. They are liable to be infected with parasitic worms since they are fed almost entirely with waste materials. They are kept solely to provide pork. (Akinyosoye, 1976).

2.2.0 PIG KEEPING SYSTEMS

2.2.1 TRADITIONAL MANAGEMENT OF PIGS

In many villages in the tropics, owners of small numbers of pigs allow them to roam about and scavenge in the neighborhood. The pigs derive their major nutrients from whatever they can pick up in backyards and refuse dumps. When these pigs are fed, they are given kitchen refuse such as peeling of cassava or yams. They drink muddy, parasite infested water from ditches. These parasite causes mortality especially among the young ones. [Akinyosoye, 1976]

2.2.2 THE EXTENSIVE SYSTEM

Under this system, the pigs spend most of their life in the open, on pasture land. Temporary sheds are provided as protection against unfavorable weather conditions for farrowing purposes. It is possible under cheap labour and inexpensive land. It's major advantages are given as follows :-

1. Capital investments are relatively low since housing and equipment are minimal.
2. Saving in feed costs are considerable as the pigs obtain some of their feeds from the pasture.
3. The pigs are not entirely dependent on the farmer for their nutrient supply, especially the supply of vitamins and minerals. This system therefore makes less demands on the farmer to feed a fully balanced diet.
4. The pigs always have an ample supply of fresh air.
5. There is no added problem of manure removal and disposal.

However its major disadvantage is that it exposes the pigs to the hazards of the weather, predators and parasites especially kidney worms, roundworms and tapeworms. [Joy & Wibberley, 1979]

2.2.3 THE SEMI-INTENSIVE SYSTEM

In this system, Akinyosoye (1979) recorded that the pigs are kept partly outdoor on pasture and partly indoor. A common form of this system is to raise breeding pigs on pasture while the growing fatting pigs are raised intensively indoors. Sometimes the breeding sows are kept outdoors during their gestation period and then brought inside the pens to farrow. The piglets and growing fattening pigs are raised indoors. A rotation may be arranged between the paddock. This, it is observed, will assist in disease control. [Akinyosoye, 1979].

Studies have shown that the paddocks should be established on well drained land which should be fenced and provided with shade [Joy & Wibberley, 1979]. Mud wallows, it is revealed may be provided or alternatively mist sprays which will reduce the body temperature, particularly during the dry season.

This system is particularly useful for breeding stock. It also leads to the production of strong healthy pigs. The consumption of green vegetation provide the necessary amount of vitamins, minerals and other food substances. The cost of feed, it is noted is reduced since the pigs depend for a proportion of their food in the green vegetation. The spread of disease is ascertained to be less and the overall cost of establishment is relatively low since the cost of feed and housing equipment are less.

2.2.4 THE INTENSIVE SYSTEM

This is basically a system whereby pigs are housed in buildings having concrete, slated or mud floor pens which can be cleaned daily [Joy & Wibberley, 1979]. With this system, some labour saving equipment such as feeding trolleys, self feeders or automatic feeder can be used. The house may be built of any suitable material with special consideration on the provision of some means of air circulation. The concrete floor, it is observed should have a rough finish to prevent the pigs from slipping on wet or muddy surface [Payne, 1990]. The feeders as recorded by [Joy & Wibberley, 1979] should be made of metal and may either fixed or movable.

In the intensive system, it is possible to group the pigs into different age and purpose groups such as weaners, growers, breeders, fattening and market stock [Eusebio, 1980]. This is for easy identification and for efficient application of disease preventive measures.

The advantages of this system are outlined below [Joy & Wibberley, 1979]

1. Parasite infestation is considerably reduced.

2. There is closer attention to pigs and unhealthy ones can be easily detected and treated.
3. It permit the introduction of labour saving mechanical devices therefore labour costs are reduced.
4. Pigs are protected from the hazards of excess heat, rain, cold, sunlight etc.
5. Feed intake and therefore growth rate can be better controlled.

However its major disadvantages include the following:-

1. Capital costs (building and equipment) can be very high
2. Proper attention must be paid to the provision of a balanced diet at all stages of the pigs life cycle.
3. It requires a good working knowledge of the nutrient and other environmental needs of pigs
4. Feed costs are higher than in the extensive and semi-intensive system. [Eusebio, 1980]

2.3.0 MATERIAL HANDLING

Material handling in general implies the movement of material in any direction. The movement of these materials from the place where it is to the place where it is needed can be expensive and troublesome. It can be damaged or lost in transit. It is important therefore that it is done smoothly, directly with the proper equipment so that it is under control at times. Several factors that must be known when a material handling system is designed include:- [Avallone & Baumeister, 1987]

1. Form material at point of origin e.g liquid, granular, sheets etc.
2. Characteristics of the materials e.g. fragile only
3. Original position of the material e.g. under the earth, in the cartons etc.
4. Flow demands e.g amount needed, continuos or intermittent, timing etc.
5. Final position where material is needed e.g. distance elevation differences
6. In transit conditions e.g. jungle, city, traffic, in plant etc.
7. Handling equipment available e.g. devices
8. Form and position needed at destination
9. Integration with other equipment and systems -

10. Degree of control required.

Other factors to be considered also include labour skills available, degree of mechanization desired, capital available, return on investment and expected life of installation.

Material handling may be divided into classifications or actions related to the stage of the process [Avallone & Baumeister, 1987]. These include:-

1. Holding, feeding and metering
2. Transferring, positioning
3. Lifting, hoisting elevating
4. Dragging, pulling, pushing
5. Loading, carrying, excavating
6. Conveyor moving and handling
7. Automatic guided vehicles, transporting
8. Robot manipulating
9. Identifying, sorting, controlling
10. Storing warehousing
11. Order picking packing
12. Loading shipping

As far as this project is concerned it is necessary to review the various handling systems vis a viz the feeding composition of pigs feeds and the housing system with a view to make some sound analysis that would enhance the design of the mechanized feeding system for the production of pigs.

2.4.0 CONVEYOR MOVING AND HANDLING

Conveyors as recorded by (Avallone & Baumeister, 1987) are primarily horizontal movement, fixed-path, constant speed material handling system. However, they often contain inclined sections to change the elevation of the material as it is moving, switches to permit alternative paths and power and capabilities to allow the temporary slowing, stooping or accumulating of materials.

It is recorded that conveyor are used not only for transporting materials but also for in process storage. They may be straight, curved, closed loop, irreversible or reversible. [Avallone & Baumeister, 1987] some types of conveyors include:-

Air blower conveyor

Apron conveyor

Belt conveyor

Bucket conveyor

Car-on-track conveyor
Chain conveyor
Flight conveyor
Hydraulic conveyor
Magnetic conveyor
Pneumatic conveyor
Roller conveyor
Screw conveyor etc.

2.4.1 FLIGHT CONVEYORS

As recorded by [Avallone & Baumeister, 1987] flight conveyors are used for moving granular, lumpy or pulverized materials along a horizontal path or an inclined seldom greater than about 40^{0}. Their principle application is in handling coal. The flight conveyor of usual construction should not be specified for a material that is actively abrasive such as damp sand and ashes.

2.4.2 SCREW CONVEYORS

The screw or spiral conveyor is used quite widely for pulverized or granular, non corrosive, non abrasive materials when the required capacity is moderate, when the distance is not more than 61m and when the path is not too steep. It substantially costs less than any other type of conveyor and is widely more dust tight by a simple cover plate [Avallone & Baumeister,1987].

2.4.3 APRON CONVEYORS

Apron conveyors are specified for granular or lumpy materials since the load is carried and not dragged, less power is required than for screw or scrapper conveyors. Apron conveyors may have stationary skirt or side plates to permit increased dept of material of the apron. (Avallone & Baumeister, 1987).

2.4.4 BELT CONVEYORS

The belt conveyor is a heavy duty conveyor available for transporting large tonnages over paths beyond the range of any other types of mechanical conveyor For this type of conveyor, it is noted the capacity may be several thousand tons per hour and the distance several kilometers. It may be horizontal or inclined upward or down ward or it may be a combination of these. The limit of inclination is reached when the materials tend to slip on the belt surface. In its simplest form, the conveyor consist of a head or drive pulley, a take up pulley , an endless belt, and carrying and return idlers (Avallone & Baumeister, 1987).

2.4.5 ROLLER CONVEYORS

Roller conveyors and used in movement of all sort of packaged goods with smooth surfaces which are sufficiently rigid to prevent sagging between rollers in ware houses, brick yards, building supply yards, post office etc.

2.4.6 PNEUMATIC CONVEYOR

The pneumatic conveyor transports dry free flowing granular material in suspension within a pipe or duct by means of a high velocity air steam or by the energy of expanding compressed air within a comparatively dense column of fluidized or aerated material. The principal use are dust collection, conveying soft material such as grain , dry food stuff (flour and feeds), chemicals, conveying hard materials such as cement. The need in processing and bulk transporting of plastic pellets, powder and flour under contamination free condition has increased the use of pneumatic conveying (Avallone and Baumeister, 1987).

2.4.7 BUCKET CONVEYORS AND ELEVATORS.

Bucket conveyors are of different types which include open top bucket carriers:-

a) The open top bucket carriers are similar to apron conveyor, except that dished or bucket shaped receptacles take the place of the flat or corrugated apron plates used on the apron conveyor. It consists of two strands of roller chain which are driven by pocket at each end.

b) V- bucket carriers are used for elevating and carrying non - abrasive materials principally coal when it must be elevated and conveyed with one piece of apparatus. These carriers can operate on any incline and can discharge at any point on the horizontal run. The size of lumps carried is limited by the size and spacing of the buckets.

C Pivoted bucket carriers

The chief application of the pivoted bucket carriers is in the dual duty of handling coal and ashes in boiler plants. They require less power than V-bucket carries as the materials is carried and not dragged on the horizontal run. The length and heights lifted are limited by the strength of the chains. They can operate on any incline and can discharge at any point on the horizontal run.

2.4.8 Bucket elevators

Bucket elevators are of two types

a) Chain and bucket where the buckets are attached to one or two chains and

b) Belt and bucket where the buckets are attached to canvass or rubber belt,

Either type may be vertical or inclined and may have continuos or non continuos bucket. Bucket elevator are used to elevate any bulk material that will not adhere to the bucket. Belt and bucket elevator are particularly well adapted to handling abrasive materials which would produced excessive wear on chains. It is advantageous for grains, cereals, glass batch , clay , coke breeze and other abrasive if the temperature is not high enough to scorch the belt Chain and bucket elevators are frequently used with perforated bucket when handling material to drain off surplus water. The length of elevators is limited by the strength of the chains or belts. The size of lumps is also limited by the size and spacing of the bucket and by speed of the elevator. (Avallone & Baumeister,1987)

2.5.0 HOUSING AND NUTRITION

2.5.1 HOUSING

According to Mcnitt (1983) there is no standard type or system of housing that will fit all conditions. The design it is observed will depend upon the climate, the particular pig enterprise (i.e. breeding or fattening or growers) and materials available locally. So based on this, pig raisers in different countries in the tropics use different designs but they have adopted certain similar principles and practices related to the choice of housing and equipment.

In deciding the kind of pig house to construct, it has been noted that pig producers should consider a house that reduce labour input but increase efficiency in management and operation. (Mcnitt, 1983) Another important feature that they should consider is the ease and degree to which good sanitation can be achieved in the house. It is accepted that clean healthy pigs can be better produced in a clean sanitary house [Eusebio, 1980].

In tropical countries, pork producers may be classified as backyard pig raisers, medium scale producers (Eusebio 1980) The other group of producers very common in tropical countries are those who let their pigs wander and scavenge with no attempt to secure maximum productivity from the pig Each types of pig raiser adopt a housing a system and facilities appropriate to the size and extend of his pig production (Mcnitt, 1983)

2.6.0 TYPES OF HOUSING

2.6.1 ELEVATED PIGSTY

As the name suggests backyard pig raising involves only a few animals perhaps 1to 3 (Eusebio 1980) which the family raise in the backyard . If the pig are not tied with rope to a tree or to one of the house they be house in an elevated battery or pigsty. This type of house may many compartments there are pigs raised by the family of which each compartments as noted should be at least 0.9m 1.0m in areas. It can be roofed with a grass such as imperata cylindrica or palm leaves such as coconut that will help to keep it cool. The house as noted should be made from cheap materials that are easily available in the regions. The floor should be slotted and made of whole bamboo wood .

Generally it has been revealed that pig raising in this type of housing is cheap and easy. However the following disadvantages has been observed. The slotted floor is not ideal for a pregnant sow as she may slip through a slot and suffer an abortion .The compartments are usually small so that sow do not have enough space on which to work for exercises (Eusebio 1980).

2.6.2 CONVENTIONAL HOUSING.

The conventional housing system, it is observed may combines several managerial operations into a single unit house or it may be made up of two units - a central pig house for both pregnant and non pregnant sow, farrowing and/or lactating sow and growing pigs and another house in which baby pigs are reared and weaned (Eusebio, 1980). These types of housing is adapted to the needs of the medium scale pork producer who keeps from 5 to 20 sows. It has been revealed that it is ideal to adopt housing construction, for instance the roofing materials should be chosen so that the inside of the house is kept cool during the hot months. (Eusebio 1980) The most suitable roofing material, it is recommended is thatch, made from the local grass or palm leaf. If the house is intended to be permanent studies have shown that the floor should be made of concrete (Eusebio 1980).A concrete floor is easier to clean and it can be kept clean more easily than any other floor. Therefore disease and parasite infestation are minimized.

2.6.3 LIFE CYCLE HOUSING

This system is designed to provide pigs with proper space and comfort during each phase of their life CYCLE (Eusebio 1980) In this system pig that have the same feeding and management requirement are place together. This reduces overall space requirement, provide maximum labour efficiency and control disease. Where 100 or more pigs are kept, it has been noted that the life cycle housing system is more economical than the conventional system (Eusebio 1980).

To provide for the need of pigs during each stage or phase of the pigs life, the life cycle housing system is composed of four units each corresponding to one stage or phase of the pigs life. The pre-gestation and gestation unit houses the breeding sow from the time they are served and fertilized until 3 days before there scheduled farrowing time. From here the sow go to the farrowing unit where they farrow and stay until farrowing time. After weaning baby pigs are raised in the baby pig nursery unit, they are eight week old or until they weigh about 12 - 15kg. After the baby pig nursery, the are housed in the growing/finishing unit until they attain market weight (Eusebio, 1980)

2.6.4 FLOOR SPACE REQUIREMENT

The amount space in the pen required by each animal it has been noted depend on the size of the animal. The ambient temperature the ventilation available in the house and the method of feeding (Eusebio 1980).

Table 1 below shows the minimum allowances of floor space suggested for the different weight categories of pigs kept in close confinement

TABLE: 1 SHOWING THE MINIMUM ALLOWANCES OF FLOOR SPACE FOR THE DIFFERENT WEIGHT CATEGORIES OF PIGS.

LIVE WEIGHT (Kg)	FLOOR AREA (m^2)
11.5 to 18.0	0.28
19.0 to 45.5	0.36
46.5 to 68.0	0.56
69.0 and above	0.74

Source: Eusebio (1980)

2.7.0 NUTRITION

The nutritional aspect of pig management involves a consideration of the feed composition, pre-treatment of feed and nutritional requirement during the different stages or phases of life, the formulation and balancing of nutrients in pig ratios and the feeding management essential for efficient pork production (Eusebio 1980)

The life cycle of pig s can be conveniently divided in to the following (Pond & Maner 1973)

A- Pre-natal period

B- The suckling period

C- The growing and finishing period and

D- The mature/ reproduction period.

The time sequence of the life cycle as recorded by (Pond & Maner, 1974) is as follows.

TABLE 2. SHOWING THE TIME SEQUENCE OF THE LIFE CYCLE OF PIGS.

PERIOD OF LIFE CYCLE	DURATION
prenatal period	114 + days
suckling period	3 - 8 weeks
Growing/finishing period (to 90kg body weight)	10 - 150 days
Age at 90kg	120-200days

source Pond & Maner (1974).

As recorded by Eusebio (1980) pig can also be grouped into different phases with respect to their ages. Thus we have

2.7.1 LACTATION/BABY PIG OR PIGLETS PHASE

This phase or stage starts from when piglets are farrowed until when they are weaned i.e. from birth to 6 weeks for early weaning and 8 weeks for late weaning {Eusebio, 1980}. It is the lactation/baby pig stage of the pig life cycle that is considered the most critical period. This is because nursing pigs as noted are low in natural body resistance. In addition, growth is rapid at this stage and body cells are multiplying fast. It is at this as have been observed that pigs utilises feed nutrient efficiently which results to growth or live weight gain. It has been revealed that for the first few days of their life, milk is the sole source of the food then later from tenth days, solid feed is introduced with an allowance of 0.2kg per animal per day in its required composition. [Pone & Maner, 1974].

2.7.2 GROWER PHASE

This phase as recorded by Pond & Maner, (1974) begins at the time of weaning and lasts until about 6 months of age. During this phase, studies have shown that the growth and development of the pig is rapid. The pigs are fed 1.0kg of feed per day per animal with 18-22% crude protein and 3000k.cal (kilo calorie) metabolizable energy diet. (Pond & Maner, 1974).

2.7.3 FINISHING STATE

It has been revealed that when a pig attains 60kg live weight its rate of growth and feed conversion efficiency decreases, so that feed requirement for production are decreased but nutrient requirements for maintenance are increased. This is because the tissue cells increases in size rather than in number and therefore the rate of metabolic exchange is less than during the earlier phase of life (Eusebio, 1980).

It is also at the growing/finisher stage that replacement gilts are selected as future breeds in the herd (Eusebio, 1980)

2.7.4 MATURE AND REPRODUCTIVE PHASE

This stage is marked by sexual maturity and reproductive activity compared to the other stages, the pig has fully developed its thermal insulation (Eusebio, 1980).

TABLE 3 THE WEIGHT OF DRY FOOD PER DAY PER ANIMAL

WEIGHT OF PIG {Kg}	WEIGHT OF DRY FOOD PER DAY FOR ONE PIG {Kg}
20	1
30	1.5
40	2.0
50 AND ABOVE	2.5

Source:- Joy & Wibberley, (1979)

2.8.0 FEEDING SYSTEM

There are basically two types of pig feeding system namely the Dry feeding system and the Wet feeding system [Culpin, 1975]. Dry - feeding system for pigs involves giving dry feed in the form of meal or pellets to the animals to feed on and then providing water separately for them to drink. In this system, pigs may be dry fed in on-the-floor or in self-feed troughs. If on-the-floor feeding is practiced, the feed is conveyed to them by an auger from a bulk hopper outside the building into small hoppers above each pen.

Tubular conveyors are also used for trough feeding for pigs. Down-drop tubes at intervals along a troth can then be used to disperse feed.[Sainsbury, 1988]

Automatic conveying can be arranged as for trough feeding using down-spout to each feeder and stopping the flow in the last feeder by fitting a pressure flap switch near the top to switch off the anger motor.

The wet feeding system involves mixing the full balanced ration with a liquid usually water. Two main system for wet feeding pigs are available in batch and continuous flow. Both system are available for hand operation and for automatic delivery of feed into the pigs by means of main pipeline with branched feeds to the pig troughs controlled by values. [Sainsbury, 1988]

2.9.0 FEED COMPOSITION AND THE FUNCTION OF FOODS

Studies have shown that only those feed nutrients that are digested can promote growth, body maintenance and production. In general the two major component of feed are water and dry matter. The dry matter is composed of proteins, carbohydrates, fats, minerals and vitamins. [Eusebio, 1980]. A well balanced pig ration it is noted should contain the necessary amounts of energy feed, protein, minerals and vitamins.

2.9.1 ENERGY.

The major source of energy are fats and carbohydrates. The energy content of the feed as by Eusebio (1980) is measured in units of heat known as calories (cal) or more commonly since this is a small unit as kilo calories (kcal) Energy values of feed are expressed as digestible energy (DE). This is the Gross energy of the feed eaten less the energy remaining in the waste products of digestion [Eusebio 1980]. The major portion on the mixed diet of pigs consists of energy feeds:-

Energy feeds include

(1) Cereal grains - maize, wheat, Rice, barley, sorghum etc.

(2) Roots crops and miscellaneous feeds e.g. cassava, sweet potatoes, Irish potatoes etc.

2.9.2 FATS.

It is recommended that a level of 1.0-1.5 fat should be present in the diet of young pigs [Eusebio 1980]. When rice or wheat bran or dry tuber are used as a source of energy and a solvent extracted oil meal such as soyabeans, groundnut or coconut is used as a source of protein, a minimum amount of fat should be added to the ration : A high fat level in the pigs' diet improves the feed efficiency [Eusebio 1980].

2.9.3 PROTEIN

The protein content of feeds expressed in terms of crude protein (CP) [Eusebio 1980]. Not all nitrogen present in feeds is true protein or amino-acid. Considerable amounts of non-protein nitrogenous substances such as urea, ammonia and nitrate are naturally present in feed materials but they are of no feeding value to pigs. Thus CP contents of a feed does not necessarily provide complete information as to how much protein is available for the pigs [Eusebio, 1980].

Protein is the most plentiful substance in the animals body next to water, and is essential in the building up of muscle and other body tissues [Mcnitt 1983]. Protein is needed in the diet of all classes of pigs to supply the amino-acids essential for the maintenance of growth, reproduction and milk production. The protein feeds supplement are soyabeans, oil meal, meat meal, fish meal etc [Eusebio 1980].

2.9.4 VITAMINS

Vitamins are organic compounds that are nutritionally essential to pigs but are required in only very small amounts. They are classified according to their solubility. [Eusebio, 1980]

2.9.5 MINERALS

The mineral elements essential for body function, it is noted may be classified into the major elements such as calcium, phosphorus, sodium, potassium, magnesium are supplied by grains or roughage [Eusebio, 1980]. The trace elements as recorded by Eusebio (1980) are commercially available as minerals premixes or vitamin/mineral premixes.

2.9.6 WATER

About 60 - 70% of the total body weight is composed of water which is second only to oxygen in importance for the maintenance of life [Eusebio, 1980], all the chemical reactions in the body as noted take place in the presence of water. It acts as a solvent for the products of digestion as a lubricant for moving parts and as a regulator of body temperature [Eusebio, 1980]. Blood is 90% water and urine is 97% water. It is also important for the proper elimination of body waste products.

In tropical countries, pigs it is noted, should be given 4-5kg of water for every 1kg of dry feed [Eusebio, 1980].

2.9.7 RATION FORMULATION

Ration formulation is the act of bringing together two or more feedstuff of indefinite proportion for the purpose of feeding the resultant ration to an animal or a group of animals performing specified functions [Eusebio, 1980].

The process of ration formulation as noted involves a number f steps which include the following (Joy & Wibberley, 1979).

(1) Knowledge of the animal

(2) Sex of animal

(3) Age of animal

(4) Weight of animal

(5) Purpose of feeding the animal

(6) Animal requirement

(7) Available feedstuff

(8) Nutrient composition data

(9) Balancing of ration

(10) Level of premix or additive

(11) Checking

The composition concerning the palatability or acceptability of a ration cannot be obtained through formulation, There is need to ensure that a ration is not only balanced in all required nutrients but also that it is palatable to the animal [Joy & Wibberley].

Having reviewed the various processes involved in the entire pig production enterprises, it can be seen that for efficient and profitable production of pigs and the associated products, mechanization of the feeding system which is labour intensive is very vital. Based on this review and other available information, a suitable feeding system that will ensure adequate handling and conserve labour and its associated costs which will make pig production an interesting enterprise is presented as follows.

best suitable method of handling it.

(4) The initial cost of installation is cheaper than any other type of handling material.

3.1.0 MODE OF OPERATION AND FUNCTIONAL REQUIREMENT OF THE DESIGN CONVEYORS(THEORITICAL ANALYSIS)

A belt conveyor must contain the following elements

(a) The belt itself
(2) The drive
(c) The support
(d) The take-up
(e) Feeding and discharge materials

3.1.1 THE BELT

There are many types of belt like the rubber leather belt etc, but the most commonest form of belt is the rubber belt. It consist of a canvass of several piles of cotton duck each impregnated with rubber and bounded together with rubber. The top is usually thicker than the underside [Badger & Banchero, 1957]. For this design, the rubber belt is utilised.

3.1.2 BELT CONVEYOR DRIVES.

Several method of driving belt conveyor exist. The simplest possible drive is a bare steel pulley actuated by some source of power. This method is satisfactory where the power that must be tranmitted is low enough to be carried by the friction of the belt on the pulley. In this type of drive, however both the area of contact between the belt and the pulley and the coefficient of the friction are small. The naxt method is to utilise pulleys covered with, rubber or leather so that the coefficeint of friction is increased. The tandem drives involves bringing the belt around one pulley and back over a second pulley (both driven). The drive of the belt conveyor is usually at the head or discharge, [Badger & Banchero, 1957]. For the purpose of this design, the bare steel pulley is utilised.

3.1.3 BELT CONVEYOR SUPPORTS

The supports for the belt are rollers on shaft supports and are usally called idlers. They are built in a large variety of forms. In general, the idlers are troughed in the centre and the edges to be raised. this permits a belt of a given width to carry more material without spillage. The belt return is ordinarily carried on ligther, non-troughing rolls and is sometimes mounted on the same base as the top idlers.

3.1.4 BELT CONVEYOR TAKE-UP

For any but the shortest conveyors, changes in load or in weather especially in temperature and humidity result in a variation in belt length of sufficeint magnitude to give an uneven tension if there is no provision for keeping the belt taut. Accordingly, a tightner or take-up must be installed to maintain an even tension on the belt under all conditions.

3.1.5 FEEDERS.

The simplest method of feeding a belt is by means of a hopper. When a hopper is used, the slopes of the sides should be such that the horizontal component of the velocity of the materials as it slides unto the belt is nearly the same as that of the belt itself. More elaborate feeding devices include short belt or apron conveyors discharging unto the main belt conveyor. For this design, the conveyor will be fed from a hopper.

3.1.6 DISCHARGING DEVICE.

The method use to discharge a belt conveyor depends on whether or not the discharge is from the end of the conveyor or at some intermediate point, and whether or not the discharge is to be at a single point or to cover the entire length of the bin. For end discharge, the belt is self-discharging, the materials simply falls off over the end. For discharge at intermediate points however, some special devices are necessary.

These methods may be listed as follows [Badger & Banchero, 1957]

(a) Scrappers
(b) Tipping idlers
(c) Trippers
(d) Shuttle conveyors

CHAPTER THREE

3.0 MATERIALS AND METHODS

In any design process in engineering, a lot of factors come into play with the functional requirements of the system to make a good design.

In this project, the following factors were taken into consideration

(1) The housing system into which the feeding system will fit.

(2) The type of feed and the targeted number of pigs that will be fed and their feeding requirements

(3) The type of handling materials to be used to convey the feed and availability of the materials.

(4) The power source to operate the system

(5) The cost benefit of the system

The design parameters are

(a) Designing a mechanised feeding system for the grower phase

(b) Each of the pigs weighs 20kg to 40kg

(c) Targetted number of pigs is 1000

(d) Floor space is $0.36m^2$ /pig, so for the 1000 pigs will be $0.36m^2 \times 1000 = 360m^2$

(e) The life cycle housing system is adopted which involves the placement of pigs that have the same nutritional requirement together in a pen.

(f) Each of the pen will contain 50 pigs, so for the 1000 pigs about 20 pens will be required.

(g) Each of the pig consumes 2kg of feed per day [Joy & Wibberley 1997] For this project work, the pigs will be fed 3 times a day i.e => 2/3kg = 0.667 kg per each feeding time/pig.
So each pen will require 0.667 x 50 = 33.33 kg per each feeding time. Total quantity of feed required for the 1000 pigs becomes 33.33 x 20 = 666.67kg.

(h) The dry method of feeding is adopted which involves serving the pigs with dry meal and providing water seperately.
Based on these considerations, a system of belt conveyor has been selcted for this design for the following reasons.

(1) The belt conveyor can travel longer distance than any other type of conveyor.

(2) It can discharge more easily than any other type of conveyor.

(3) Considering the type of material to be conveyed, it is the

3.2.0 POWER REQUIREMENTS

The total power required to operate a belt conveyor is the sum of the requirement for

(1) Moving the empty belt over all idlers.

(2) Moving the material load horizontally

(3) Lifting or lowering the load

(4) Turning the end pulley and other moving parts under the load - simply referred to as power due to accessories [Day & Benjamin, 1991]

(1) Power required to drive empty belt is given by

$$Peb = \frac{Teb}{33000} = \frac{(T_i + T_b)\,s}{33000} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

[Day & Benjamin, 1991]

where

Peb = power required to move an empty belt

s = Belt speed

Teb = the differential tension or pull in the belt required to move main conveyor parts

Tb = required pull or tension to move the belt

Ti = empty belt tension needed to mave the idlers

But

$$Ti = (b_f w_i)\ \frac{L}{d_i} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

[Day & Benjamin, 1991]

where

W_i = weight of an idler

d_i = diameter of the idler shaft

L = length of belt tension between head and tail pulley

b_f = fraction factors on idler bearing value betwee 0.015 and 0.035

For this design

s = 0.15m/s

d_i = 20mm

W_i = 2.5kg

L = Depends on the length of the whole pond - 20000mm

bf = 0.05

hence T_1 = (0.02 x 2.5) $\frac{20000mm}{20mm}$

= 62.5kg

Tb = (bfr + bft) wbL .... (3)

[Day & Benjamin, 1991]

where

Tb = Required pull of tension to move belt

bfr = Idler bearing function where belt is on return idlers usually given as 0.015

bft = Idler bearing friction where belt is on full tension [values of 0.035 to 0.016]

Wb = weight of the belt

L = Length of belt between head and tail pulleys for this design

bfr = 0.015

bft = 0.0255

Wb = 300kg

= Tb = [0.015 + 0.0255] 300 x 20

= 0.0405 x 300 x 20

= 243kg

but Te = T_1 + Tb

where

Te = Differential tension or pull in the belt required to move main convayor parts

T_1 = Empty belt tension meeded to move the idlers

Tb = The requred tension to move the belt

=> Te = 62.5kg + 243kg = 305.5kg

Therefore

Peb = $\frac{Te\ s}{3300}$ (watt) .... (4)

[Day & Benjamin, 1991]

Where Te = As defined above

S = speed of convayor

Peb = $\frac{305.5 \times 0.15}{33000}$

= 345.0711w

But power due to the accessories is given by

Pe = fe x Peb........................(5)

[Day & Benjamin, 1991]

where

Pe = power due to accessories

fe = Accessory power factor

Peb = power required to drive empty belt

fe is usually given as 3 for 18" in [457.2mm] belt width

[Day & Benjamin, 1991]

hence

pc = 3 x 345.07118w

= 1035.2136w

2. Power required to move material horizontally

$$Phm = \frac{bfwmLs}{33000} \quad \text{.............................(6)}$$

where bf = Idler bearing friction

wm = Weight of material = 33.3qls with q as the capacity of the conveyor

L = Length of belt between head and tail pulley

s = belt speed

calculating for capacity q

qt = Fur kg/s.....................(7)

where

F = Area of vertical section m^2

U = Speed m/s

r = density of the material kg/m^3 = 320.37kg/m^3

From table 10.4, [Day & Benjamin, 1991] the cross sectional area of belt load for a 457.2mm belt with surcharge angle of 20^0 is 0.0046199m^2

qt = 0.0046199 x 0.15 x 320.37

= 0.222kg/s

=> wm = 33.3 x 0.222 = 7.393

$$Phm = \frac{0.025 \times 7.393 \times 20 \times 0.15}{33000}$$

= 41.259581w

But Ph = Phm + Pam (watt)

where

Ph = power to move the material load horizontally for a 20m conveyor length Phm $\simeq$ Pam [Day & Benjamin, 1991]

Ph = Phm x 2

= (41.259581 x 2) w

= 82.519162w

Hence the total power required is given by

P = Pe + Ph ....(8)

= (1035.2136 + 82.519162) w

= 1117.7328w

= 1.12kw or 1.5hp

To take care of losses, a 2 horse power motor is selected which is approximately 1.5kw

3.3 LENGHT OF BELT (L)

From the formula

$$L = 2l + 1.57\ (D_1 + D_2) + \frac{(D_1 - D_2)^2}{4l} \qquad (9)$$

(Avallone & Baumeister, 1987)

Where l = the center distance between head and tail pulley

D_1 and D_2 = Head and tail pulley diameter

but D_1 and D_2 have the same diameter 36mm

l = 20m = 20000m

hence l = 2(20000) + 1.57 (2x36)

= 40000 + 113.04

= 40113.04mm

= 40.11m

3.4 DETERMINATION OF THE TENSIONS ON THE BELT

The analysis of the tension on the belt is necessary in the determination of the various stresses of the belt. This in turn is used to calculate the maximum stress of the belt, and then [illegible] or conclude if this stress falls within the limit of the allowable stress of the particule belting.

This analysis is made as follows:-

In determining the tensions on the belt (slack and tight sides), the service factor of the machine is multiplied with the horse power rating. The service factor of conveyor belts are usually given within 1.2 & 1.4 (Avallone & Baumeister, 1987). Taking an average of 1.3, hence sf x hp = 1.3 x - 2.6hp, converting this power to watt gives

2.6 x 745.7 = 1938.82w

But power p is given by

p = Fv.................. (10)

where p = Power

F = Force

V = Speed of belt

=> 1938.83 = f x 0.15

hence

$$F = \frac{1938.82}{0.15}$$

But F = 1.88 Te ....(11)

where Te = effective tension of the belt

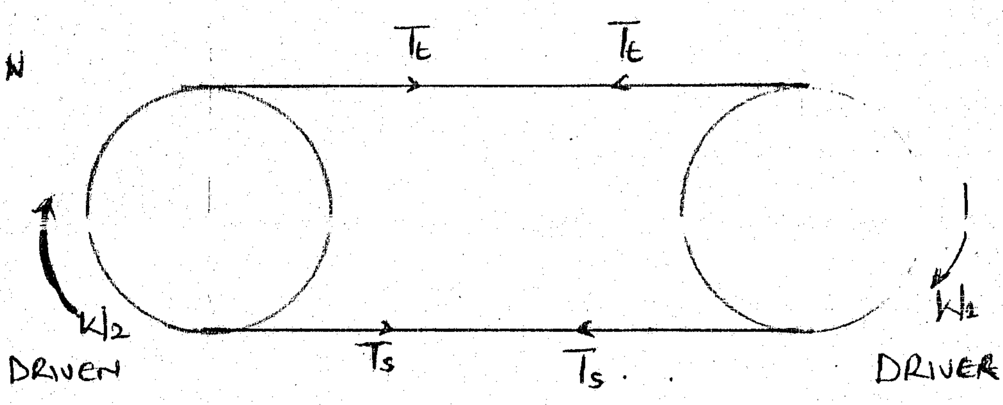
6462.73 = 1.85 Te

hence

$$Te = \frac{6462.73}{1.85}$$

Te = 3493.37N

Fig 1: The tensions on the belt



But Te = Tt - Ts ....(12)

where

Te = The effective tension

Tt = The tight side tension

Ts = The slack side tension

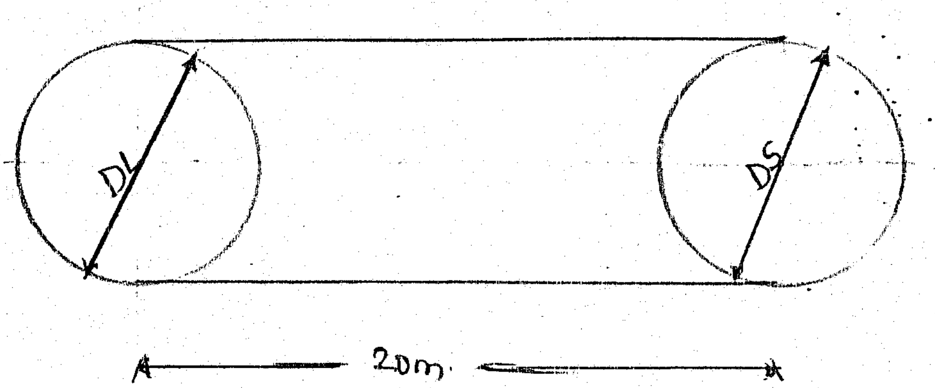
and from relation

$$\frac{Tt}{Ts} = e^{u\theta} \quad \text{.................... (13)}$$

where u = coefficient of friction = 0.25

θ = angle of lap

and Tt, Ts as defined earlier.



$$\frac{\cos\theta}{2} = \frac{DL - DS}{2c} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

where DL = The diameter of the large pulley

DS = The diameter of the smaller pulley

But DL = DS here

Hence $\cos \frac{\theta}{2} = 0$

therefore $\frac{\theta}{2} = \cos^{1} 0$

$\frac{\theta}{2} = 90$

therefoer $\theta = 180^{0}$

Changing to radians gives

180 x 0.0174532 = 3.141593

Thus

$$\frac{Tt}{Ts} = e^{0.25 \times 3.1415927}$$

$Tt = Ts\, e^{0.7854}$ Substituting Ts in equation 12 gives

Te = 2.19328 Ts - Ts

3493.37 = 1.19328 Ts

Hence $Ts = \frac{3493.37}{1.19328} = 2927.5359N$

But Tt = 2.19328 Ts

therefore

Tt = 2.19328 x 2927.5359N

Tt = 6420.9050N

3.5 DETERMINATION OF THE STRESSES OF BELT

Belt drive depens for their operation on friction between the belt and the pulley(s).

To develop adequate friction, the belt must be given a certain amount of pre-tension To, whose value should be chosen such that the initial stress ro in the cross section of the belt is within 1.5 and 2.0 Mpa (Avallone & Baumeister, 1987)

If the belt is assembled with an initial tension To, when power is being transmitted, the tension in the tight side increase from To to Tt and on the slack side, it decreases from To to Ts. If the belt is assumed to obey Hookes law and its length is to remain constant, then the increase in length of the tight side (Tt) is equal to the decrease in length of the slack side Ts i.e. Tt-To=To-Ts.

Since the length and the cross section area (A) of the belt are the same on each side

Then $Tt + Ts = 2To$................ (15)

Hence

$6420.9059 + 2927.5359 = 2To$

$9348.448 = 2To$

$To = \frac{9348.4418}{2}$

$To = 4674.2209N$

But the pretensional force $To = \sigma_0 A$

therefore $To = \sigma_0 A$........................ (16)

where

To = Initial stress

A = Cross sectional area of belt

But To = 1.75Mpa

Hence

$4674.2209 = 1.75 \times 10^6 A$

$A = 0.0026.709m^2 = 26.709 \times 10^{-4}m^2$

=> $A = 2670.9mm^2$

The ratio of turning force to the cross section area of the belt

$\frac{Te}{A} = kr$ .... (17)

Where

Te = Effective tension

A = Cross section area of belt

kr = Effective stress

hence

$kr = \frac{3493.37}{26.709 \times 10^{-4}}$

$= 1307937.4pa$

$= 1.308Mpa$

But $r_1 = \frac{Tt}{A} = r_1 + \frac{kr}{2}$ .... (18)

$r_2 = \frac{Ts}{A} = r_2 - \frac{kr}{2}$ .... (19)

By subtracting equation (19) from (18), we have

$\frac{Tt}{A} - \frac{Ts}{A} = r_1 - r_2$

But $r_1 = \frac{Tt}{A}$

Hence $r_1 = \frac{6420.9059}{0.0026709}$

$= 2.404Mpa$

$r_2 = \frac{Ts}{A}$

$= \frac{2927.5359}{0.0026709}$

$= 1.096Mpa$

But $kr = \frac{Te}{A} = r_1 - r_2$

Therefore $kr = (2.404 - 1.096)Mpa$

$= 1.308Mpa$

Computation of the stress caused on the belt by the contrifugal force.

As the belt moves at a speed v_1 all of its particle describing the curvilinear path experiences centrifugal force of inertia. These forces gives rise to an additional tension (Tv) in all the cross section of the belt and is given as

$Tv = qAv^2$ ....(20)

(Day & Benjamin, 1991)

where

q = the tightness of the belt

A = The cross sectional area

v = The speed of the pulley

Thus rv is the stress caused on the belt the the Tv

But $Tv = \frac{1}{3} Tt$ ....(21)

where Tv = centrifugal force

$$Tv = \frac{1}{3}(6420.9059)$$

$$= 2140.302N$$

But

$$rv = \frac{Tv}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

$$rv = \frac{2140.302}{0.0026709}$$

$$= 0.08139189Mpa$$

Computation of the bending stress

The bending stress is given by the equation

$$r_b = \frac{Et}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

where E = Modulus of elasticity of belt

= 1.80 Mn/m^2

t = thickness of the belt taken 3mm

d = pulley(s) diameter = 360mm

$$\sigma_b = \frac{1.8 \times 106 \times 0.003}{0.36}$$

$$= 0.15MN/m^2$$

hence

$$rmax = r_1 + r_v + r_b$$

$$= (2.404 + 0.801 + 0.15)Mpa$$

$$= 3.355Mpa$$

which is within the limit of the allowable stress of rubber belting 2 - 3.45MPa

3.6.0 POWER TRANSMISSION ANALYSIS

3.6.1 V - BELT DESIGN

Electric motor selected speed = 1440rpm

Horse power = 1.5kw

An - A - series V - belt is adopted because the horse power of the electric moter selected falls within the range of the electric power given for the A - series (Design Data, 1992).

Diameter of the larger pulley can be calculated using the equation

$$N_1 D_1 = N_2 D_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (24)$$

Hence

$$D_2 = \frac{N_1 D_1}{N_2}$$

Where

D_2 = Diameter of larger pulley = ?

D_1 = Diameter of the smaller pulley = 75mm

N_1 = R.P.M. of smaller pulley = 1440rpm

N_2 = R.P.M. of larger pulley = 300rpm

Substituting the values into equation 25 above gives

$$D_2 = \frac{1440 \times 75}{300}$$

The speed ratio of the belt will be equivalent to the ratio of the pulley(s) diameter.

i.e. $i = \frac{D_2}{D_1}$

where

D_2 = Diameter of the larger pulley

D_1 = Diameter of the smaller pulley

$$i = \frac{360}{75} = 4.8$$

3.6.2 Computation of the tension on the belt.

The belt tension can be computed from the expression

$$\frac{T_1 - MV^2}{T_2 - MV^2} = e^{fx/\sin\frac{1}{2}\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (26)$$

(Design Data 1982)

where

T_1 = Maximum permissible tension of the belt

M = Mass of belt

θ = Groove angle of pulley (since a V-belt drive is adopted, the groove angle is 40^0) (Design Data, 1982)

f = Coefficient of friction between belt and pulley usually given as 0.25

α = Velocity of belt computed from

$$V = \frac{\lambda d_2 N_2}{60} = \frac{\lambda \times 0.360 \times 300}{60}$$

V = 5.66m/s

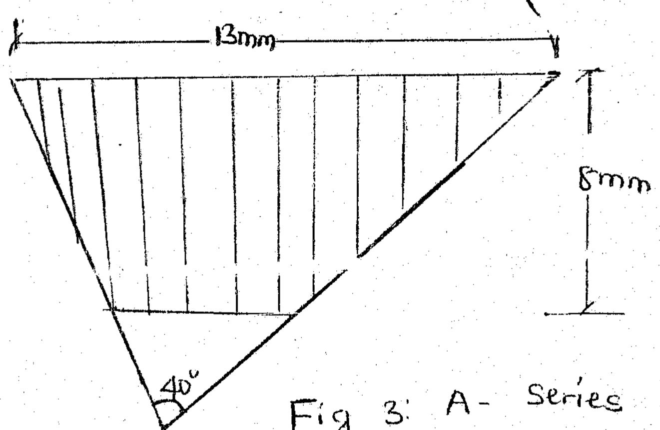


Fig 3: A- Series V-b details

Density of belt is given as $1250kg/m^3$

Maximum permissible stress of belt = 1.75Mpa

Adopting an A - series V - belt with details as shown in the figure above.

hence

T_1 1.75 x 106 x 13 x 10^{-3} x 8 x 10^{-3} = 182N

But mass of belt = ζbt kg/m of length

where

ζ = density of belt

b = 13mm

t = 8mm

hence

mass of belt = 1250 x 13 x 10^{-3} x 8 x 10^{-3} = 0.13kg/m of length

Angle of wrap is computed as follows

$\alpha = 180 \pm 2\beta$ ....(27)

But

$\sin\beta = \frac{D_2 - D_1}{2c}$ (Machine design Schaum series 1961)

where

D_2 = Diameter of larger pulley

D_1 = Diameter of smaller pulley

C = Centre distance between the two pulley

But

$C = 0.55\ (D_2 + D_1) + T$

where D_1 and D2 = As defined above

T = Norminal belt thickness (mm) usually given as 8 for A series v belt (Design Data, 1988)

hence

C = 0.55 (360 + 75) + 8

= 247.25

≃ 250mm

$B = \sin^{-1}\left(\frac{360 - 25}{2 \times 250}\right)$

$= \sin^{-1}\left(\frac{285}{500}\right)$

= 34.750

$\alpha_1 = 180^0 - 2(34' 75^0)$

$= 110.5^0$

Therefore belt tension

$$= \frac{176.8 - 0.13 \times (5.66)^2}{T_2 - 0.13 \times (5.660^2} = Q^{0.25(249.5)/\sin½(40)}$$

$$= \frac{172.64}{T_2 - 4.164628} = 3.18$$

$$\Rightarrow T_2 - 4.164628 = \frac{172.64}{3.18}$$

$$T_2 - 4.164628 = 54.28930818$$

$$T_2 = 58.45N$$

therefore

$$T = T_1 + T_2 = 176.8 + 58.45N$$

$$= 235.254N$$

3.6.3 LENGTH OF BELT

From the relation

$$L = 2c + \frac{\lambda}{2}(D_1 + D_2) + \frac{(D_2 - D_1)^2}{4C} \quad \ldots\ldots\ldots\ldots\ldots\ldots (28)$$

since

$C = 250mm$

$D_2 = 360mm$

$D_1 = 75mm$

hence

$$L = 2 \times 250 + \frac{\lambda}{2}(360+75) + \frac{(360+75)^2}{4x250}$$

$$= 500 + 683.296 + 81.225$$

$$= 1264.521mm$$

$$= 1264.5mm$$

$$\simeq 1265mm$$

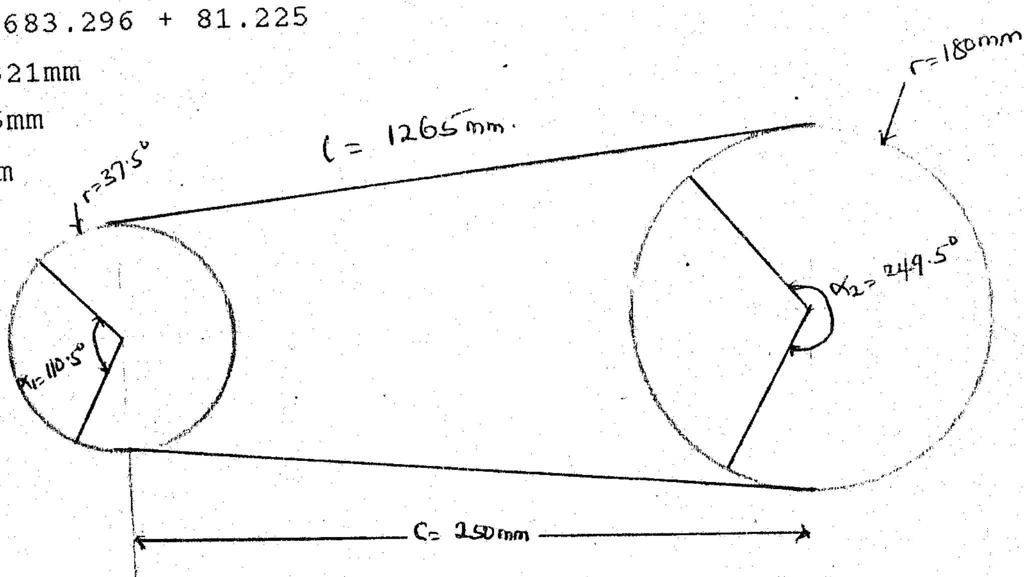


figure 4. Angle of wrap and centre distance of belt

3.7 SHAFT DESIGN AND BEARING SELECTION

The Power Drive Shaft

The total weight acting on the shaft can be calculated as follows:

Ta = belt drive tension = 237.6N

Tb = the sum of the effictive tension on the conveyor (Te) = (Tt + Ts), the weight of the belt and the weight of the material carried by the conveyor

Te = Tt + Ts = 9348.45N

Weight of belt = 300kg x 9.81 = 327N

Hence Tb = (9348.45 + 2643 + 327)N

= 12291.78N.

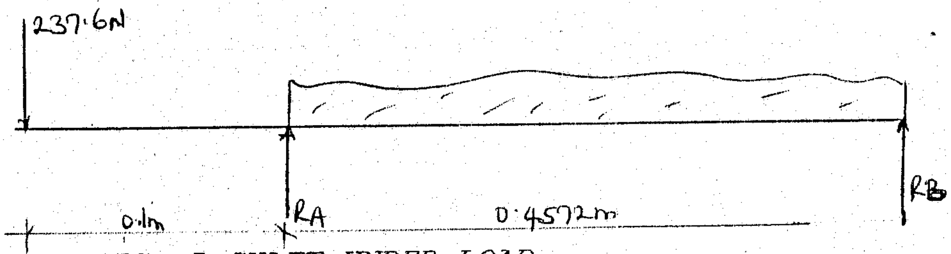


FIG. 5 SHAFT UNDER LOAD

The shaft can be treated as a beam carrying a uinformly distributed load of 26884.91N/m over a length of 0.4572m and tension of 237.6N

$\Sigma v_f = 0$

$R_A + R_B = 237.6 + 12291.78 = 12529.38N$ ....(29)

$\Sigma M_A = 0$

$$237.6 + 0.1 + R_B \times 0.4572 = 12291.78 \times \frac{0.4572}{2}$$

$>> 23.76 + 0.4572R_B = 2809.9009$

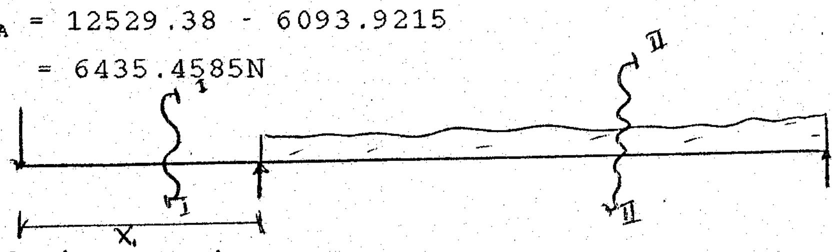
$$R_B = \frac{2809.9009 - 23.76}{0.4572}$$

$R_B = 6093.9215N$

Putting R_B in equation 29

$R_A = 12529.38 - 6093.9215$

$= 6435.4585N$



Considering section I-I

$0 \leq x_1 \leq 0.1m$

$V_{x1} = 237.6N$

Also $M_{x1} = -237.6x_1$ at $x_1 - 0$; $Mx_1 = 0$

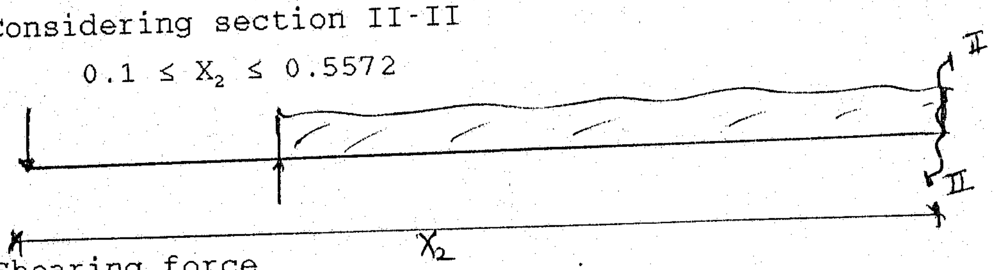
at $x_1 = 0.1m$

$M_{x1} = -237.6 \times 0.1$

$= -23.76Nm$

Considering section II-II

$0.1 \leq X_2 \leq 0.5572$



Shearing force

$-237.6 + 6435.4585 - 26884.91(X_2 - 0.1) + V = 0$

$V = 237.6 - 6435.4585 + 26884.91(X_2 - 0.1)$

at $X_2 = 0.1$

$237.6 - 6435.4585 + 126884.91$

$V = -6197.8585N$

at $X_2 = 0.5572$

$V = 237.6 - 6435.4585 + 26884.91(0.5572 = 0.1)$

$= 6093.9225N$

Bending moment

$\Sigma M_{I\text{-}II} = 0$ $\quad\quad 0.1 \leq X_2 \leq 0.5572$

$M_{XII} = -237.6X_2 + 6435.4585(X_2 - 0.1) - 26884.91(X_2 - 0.1)\frac{(X_2 - 0.1)}{2}$

at $X_2 = 0.1$

$M_{XII} = -237.6(0.1) + 6435.4585(0.1-0.1) - 268841.91(0.1-0.1)\frac{(0.1-0.1)}{2}$

$= -23.76Nm$

at $X_2 = 0.2785$

$M_{XII} = -237.6(0.2786)+6435.4585(0.2786-0.1)-26884.91(0.2788-0)(0.2786-0.1)/2$

$= -66.19536 + 1149.3729 - 26884.91(0.1786)0.0893$

$= 654.39065N$

At $X_2 = 0.5572$

$M_{XII} = -237.6(0.5572)+6435.4585(0.5572-0.1) - 26884.91(0.5572-0.1)(0.5572-0.1)/2$

$= -132.39072 + 2942.2916 - 26884.91(0.4572)(0.2286)$

$-132.39072 + 2942.2916 - 2809.9011 - 0.00022 \simeq 0$

In view of the bending moments calculated, it can be seen that maximum bending moment Mb = 654.39065Nm

For the diameter of the shaft from the relation

$$d^3 = \frac{16}{\pi S_s}\sqrt{(K_b M_b^2 + (K_t M_t)^2} \ldots\ldots\ldots (30)$$

(Machine design Schaum series 1961)

where

S_s = Allowable shear stress = 40 x 10^6 for shaft with keyway

K_b = Combine shock and fatigue factor applied to beinding moment = 1.5 for solid shaft.

Kt = Combine shock and fatigue factor applied to torsional moment = 1.0 for solid shaft.

Mb = maximum bending moment on the shaft

Mt = Torsional moment

But

$$Mt = \frac{9550 \times kw}{RPM} \text{ Nm}$$

(Machine design schaum series 1961)

$$= \frac{9550 \times 2}{1440} = 13.26\text{Nm}$$

Substituting the values into equation 30 we have

$$d^3 = \frac{16}{\pi \times 40 \times 10^6}\sqrt{(1.5 \times 654.39065)^2 + (1.0 \times 13.26)^2}$$

$$d^3 = \frac{16}{1.25664 \times 10^8}\sqrt{963511.03 + 175.8276}$$

$$d^3 = \frac{16}{1.25664 \times 10^8}\sqrt{963686.86}$$

$$d^3 = \frac{16}{1.25664 \times 10^8} \times 981.67554$$

d^3 = 0.0001249

d = 0.04999m = 0.050m = 50mm

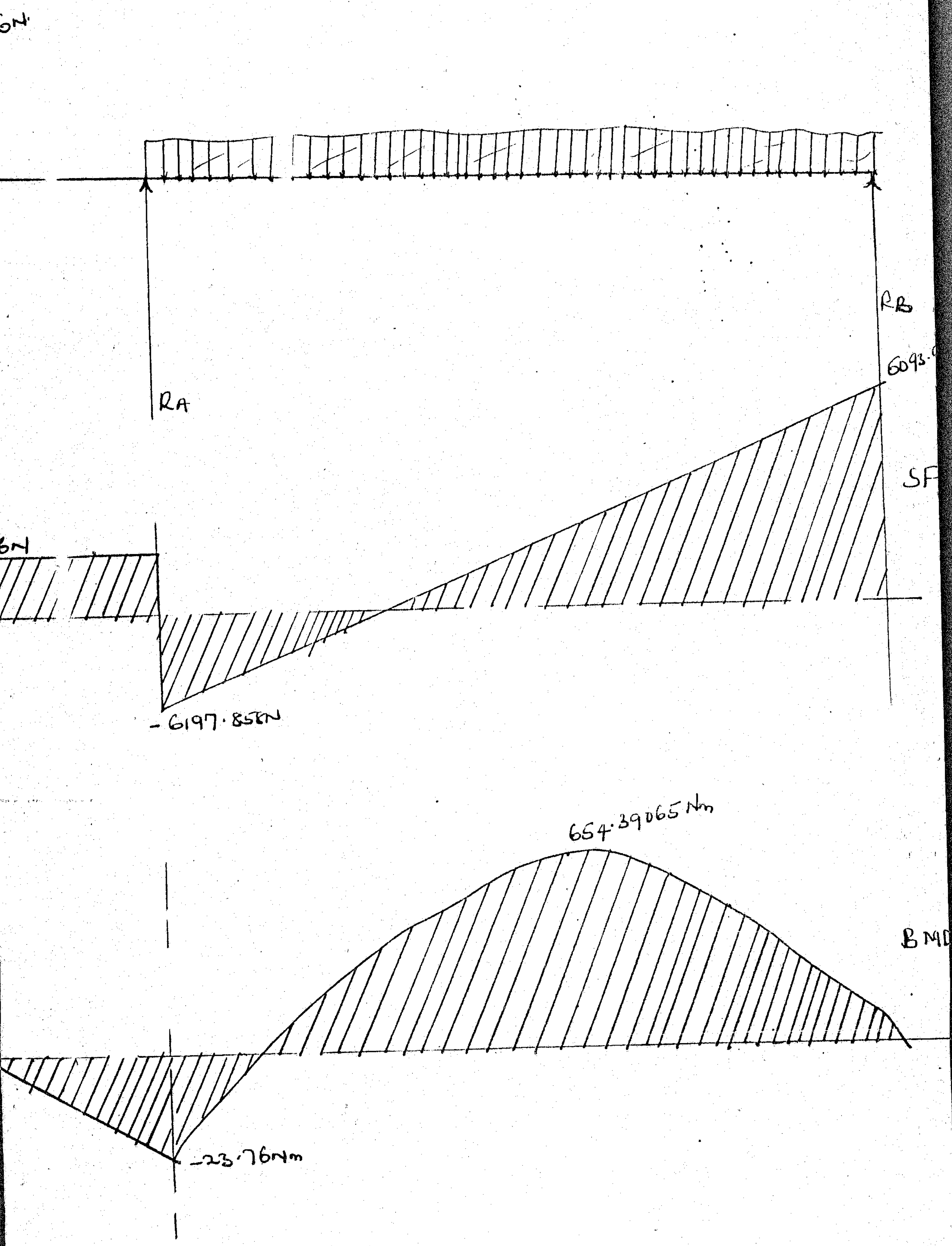


Fig. 6 Showing the shearing force and bending moment diagram.

3.7.2 BEARING SELECTION

For the purpose of this design, a deep groove ball bearing shall be adopted. Also an operating life of 20000 - 30000 hours is recommended for belt conveyors. (Maitra & Prasad, 1986)

$$Lh = \frac{1000000}{60n} (c/p)^k \quad \text{.......................(31)}$$

(Maitra & Prasad, 1986)

Where

Lh = Life of the bearing in operating hours

n = Speed in r.p.m

c = basic dynamic load on the bearing

choosing Lh = 20,000hours

n = 300rpm

p = the highest shaft reaction = 6435.4585N

hence $20000 = 1000000/60 \times 300 \times C^3/6435.4585^3$

$20000 = 55.56C^3/6435.4585^3$

$55.56C^3 = 5.3305065 \times 10^{15}$ 9.5941442×10^{13}

$C^3 = 9.5941442 \times 10^{13}$

C = 45779.258

With the diameter of the shaft as 50mm and basic load ratings as 45779.254, a number 6310 ball bearing is selected with 50mm internal diameter and 110mm outside diameter. (Maitra & Prasad, 1986).

3.8.0 STANDING SUPPORT DESIGN

For axially and laterally loaded frame

$fe/pc + fbc/pbc \leq 1$ ....(32) (Maitra & Prasad, 1986)

where

fe = Actual direct axial stress

fbc = Actual direct bending stress

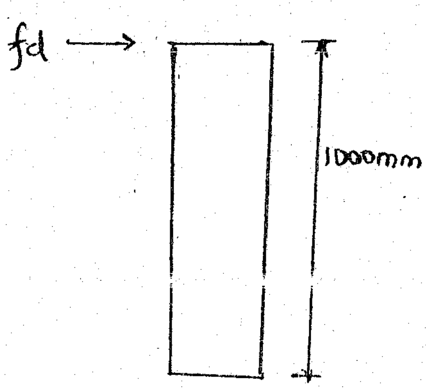
pbc = Allowable bending stress

pc = allowable axial stress

but $fbc = M/Z$.........................(33)

where M= moment

Z = Sectional modulus



$M = fd \times 1000$

where fd = Force acting on the belt

$fd = 12291.78N \times 1000$

$= 1291780Nmm$

From table NO. 3.16 (Maitra & Prasad)

Selecting a channel of standard ISJC 150, we obtain that

Thickness = 3.6mm

Sectional modulus $Z = 62.8cm^3 = 62.8 \times 10^3\ mm^3$

and Area $Ax = 12.65cm^2 = 12.65 \times 10^2\ mm^2$

Therefore fbc fd/Z

$fbc = 12291780Nmm/62.8 \times 10^3\ mm^3$

$= 155.73N/mm^2$

fc = Vertical load (pv) on each leg/area of frame Ax

Where pv = Total load acting downwards/No. of legs

$pv = 237.6 + 2943 + 327/16$

$= 3507.6/16$

$= 219.225N$

Therefore $fc = 219.225/12.65 \times 10$

$= 0.173N/mm^2$

$pc = 0.6 \times \delta y$ 34

Where

δy = yield stress

using steel frame

$\delta y = 0.55 + 0.65/2 \times 450\ N/mm$

$= 270N/mm^2$

$pbc = 165N/mm^2$ (standard for steel) (Maitra & Prasad, 1986)

Substituting the values into equation (32) gives

$fc/pc + fbc/pbc = 0.173/270 + 155.73/165$

$= 6.407 \times 10^{-4} + 0.9438$

$= 0.9444$

That is $fc/pc + fbc/pbc < 1$

Therefore the frame designed is safe for the conveyor.

Thus use ISJC 150 channel of thickness 3.6mm.

3.9.0 MODE OF OPERATION

The basic components of the designed belt conveyor include the following;

(a) An 18" wide belt
(b) Troughnening rollers
(c) Return rollers
(d) Main frame
(e) A 2hp electric motor
(f) A reduction gearbox
(g) A rail
(h) Head and tail driving pulleys
(i) Moving wheels
(j) Vee belt

The conveyor is driven by a 2hp electric motor with a reduction gearbox. The speed of the electric motor is 1440rpm which is very high for the conveyor and so has to be reduced to a very slow speed by the gearbox. The material is fed to the belt from a hopper mounted above the belt conveyor. The belt conveyor can move forward or backward with the assistance of an electric switch. The material from the belt is delivered or discharged to the desired pen and since the belt can be directed to move either forward or backward, it then means that two different pens can be served one after another with the belt conveyor at the same point.

With the provision of movable wheels on the frame, the entire conveyor belt can be moved on the rail electrically to any of the pen. With this arrangement, the feed is conveyed and discharged to all the 20 pens conveniently.

3.9.1 PROVISION OF DRINKING WATER

The dry feeding method involves the feeding of dry feeds to the animals and providing water seperately. Since this project work is aimed at mechanizing the feeding system so as to reduce the labour involved in manual feeding, the water too is automated. For this design, about 5 press taps are fixed in each of the 20 pens so that the animals can turn on the water with their snouts thus ensuring a clean water.

CHAPTER FOUR

4.0 DISCUSION CONCLUSION AND RECOMMENDATION

4.1 DISCUSSION.

From investigation carried out on two different Nigerian pigs farmers in two different locations. It was found that it took one of the farmers in the southern part of the country who provided water automatially for his pigs but feed them manually 60mins to feed his 50 pigs for each feeding time. This farmer feed his animal three times a day making a total of 60 x3 = 180mins per day.

It was also found that it took another farmer located in the northern part of the country who both feed and provide water manually 90mins to feed his 30 pigs. He also feed his animals 3 times a day making a total of 90 x 3 = 270mins per day.

If these Nigerian pig farmers were to feed the targetted 1000 pigs 3 times a day, It will take the farmer who manually provides feed and water for the animal 3 mins/pig x 1000 pigs = 3000mins/each feeding time and 3000 x 3 = 9000mins per day. And for the farmer who feeds his animal manually and provides water automatially 1.2mins/pig x 1000 = 1200 mins/each feeding time and 1200 x3 = 3600mins which will be very tedious since they cannot even complete the feeding within a day. With the current designed mehanized system, it is expceted that it will take about 10mins to serve a pen and since the system is moved electrically, it will take a maximum of 2 mins to move from one pen to another making a total of 400miutes to move through the entire pens so the total time to serve the animal/each feeding time = 10 x 20 pens = 200mins + 40mins/each feeding time and since the animal are fed 3 times a day = 240 x 3 = 720mins per day. Comparing this time reduction in percentage, it could be seen that the time for feeding the animal when the designed system is adopted is just 8% of the time the farmer who feeds and provides water for his animals manually i.e 720/9000 x 100%

= .08 X 100%

=8%

And about 20% of the time the farmer who feeds manually and provides water automatically for his animals.

i.e 720/3600 * 100%

0.2*100%

= 20%

If these farmers were to pay for the labour and assuming they pays N5 per hour to the labourer, the farmer who feeds and privides water manually for his animals will have to pay 9000/60 * N5 = N750 per day.

But for the designed system only 720/60 * N5 =N60 per day will be spent.

With the redution in time and labour cost the designed system will help the farmers to increase their production and at the same time use the time saved for other activities. The developed system apart from increasing the output will also increase the farmer's income.

Since the ultimate goal of any business man is to have the best, adopting the current system will help tremendiously in making the pig production which hitherto has been relegated to the background because of the problem involved in the feeding a viable venture. Since the capital return or turn over from pig prodution is great compared to other animal prodution due to the large number of piglets usually released per litter, it would be worthwile to adopt the mechanised feeding system such as this.

Increase in procdution of pig could spring some other related industries e.g. meat processing, hence creating further job opportunities

4.2 CONCLUSIONS

The main objective of this project work is to develop a mechanised feeding system which will reduce the labour involved in the manual feeding of pigs. With the designed system it could be seen that the aim of the project was achieved because the time and labour involved is the feeding of animals is only 8% of the time involved in the manual feeding of the animals using this system.

This is geared toward the improvement of the local technologies so as to boost production and improve the lives of the populace expecially in protein consumption through increase in pigs and pigs products.

4.3 RECOMMENDATION

In project of this nature it is not completely easy to exhaust every aspetct. Thus several ground are still left for further work. In view of this, the following recommendations are here by made for further work .

1. The system should be tried in a farm to see how it performs, inspite of the initial cost which can eventually be recovered or overcomed in no distant time.

2. The entire system an be automated with the aid of current advancement in computer tehnologies.

3. Regular maintenace of the system to ensure durability.

4.4 BILL OF THE DESIGNED SYSTEM

Materials	specification	quantity	Total price (=N=)
Electric motor	2hp	1	25,000.00
Gear box		1	12000.00
Belt	18"	40.inlength	15,000.00
Idlers		60	30,000.00
Return Rollers		12	6,000.00
Pulleys End	36mmdia	2	2,000.00
wheels		20	6,000.00
Rail	2" * 2"	2	2,400.00
Stand	Chanell	16	10,000.00
v-belt		1	200:00
V-groove pulley		1	250.00
Press taps		100	10,000.00
Water pipes	30mmdia		3,000.00
		Total =	**121~~8~~,850.00**

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4.5: DEFINITION OF TERMINOLOGIES USED IN THE TEXT

Prolific	- Producing many young
Pen	- compartment for pigs
Sow	- The female parent
Sire	- The male parent
Litter	- set of young pigs born at one time to the mother pig.
Weaning	- Transfering the young pigs from dependence on the mother's milk to another form of fee
Piglets	- The young pigs being given birth to at each litter
Farrowing	- Process of giving birth to a litter of pigs by a mother sow
Feed Efficiency	- Amount of feed required for an animal to make a unit gain in weight.
Lactation/Baby phase	- From the time of birth to when the piglets are weaned
Growing phase	- From weaning to when the pig weighs up to 40kg body weight.
Finishing phase	- From the time the pig weighs 40kg to the market stage ie 40kg to 90kg body weight