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Inclined Coarse Aggregates Washer

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Abstract

The study focused on the development of an inclined coarse aggregates washer, a machine intended to be used for washing coarse aggregates sample during sieve size analysis in testing laboratory shop for construction materials. The present invention relates to washing machine and more particular to a machine used for washing coarse aggregates using an outer cylinder container and a perforated inner cylinder container with plastic bar mixer driven by a motor in an angular position aided with continuous flow of water to wash coarse aggregates without damaging and help the laboratory technicians to make aggregates washing easier, faster, and more convenient with more quantity and quality output. Specifically, this study aimed to design an inclined coarse aggregates washer, estimate the cost of supplies and materials, construct and test/evaluate the functionality of the project. The machine is a substitute for a tedious process of washing and drying method of aggregates using bare hands. It is intended to avoid and eliminate the risk of hand injury due to manual practice. The laboratory technicians can use their bare hands and in so doing it would expose their hands to water and heat during washing and oven drying process that may result to injury and palsy hands. The major parts of this machine are the stainless container assembly, the motor, and pulley and belt assembly. The machine is limited to wash the ordinary or crushed gravel with maximum size of G1 and with a maximum capacity of five kilos of gravel. Based on the analysis conducted, the project was designed and developed according to the purpose as it is a good substitute for manual process of washing coarse aggregates; functions very efficiently. It is therefore recommended that this newly developed machine be used in the construction material testing laboratories and to be used as an additional equipment for instructional purposes in the civil technology shop.

Keywords: Coarse aggregates, Washer, Aggregates washing, Sieve size analysis

I. INTRODUCTION

Technology innovation is important because it may give simple solution for health or human services to maximize individual ability to respond to surges of need for some emerging tools, services and applications that can improve efficiency and capacity. Technology has developed machinery and equipment for purposes of improving the efficiency and effectiveness and to increase production.

Every now and then, industrial processes change due to the emerging of new technology. Technology plays a very important role in innovation. To make a difference, it has to be appropriately applied to solve specific problems or meet certain goals. To maximize the value of that difference, it is essential to apply only the smallest amount of technology to the areas that stand to benefit from it. Innovation only happens when people use technology to provide a real or perceived value to customers. Along with the increasing importance of innovation and the role played by technological capabilities in a firm's growth trajectory, little is known how technological innovation in different organizations is driven by their technology strategy, the plan that guides the accumulation and deployment of technological resources and capabilities. The current dynamic environment

demands all organizations to change – both radically and incrementally. Sustainable development cannot happen without innovation. It is very essential for an organization to change the way it operates and to change the products and services it provides (Dasgupta, 2008).

The rapid growth in population and the increasing demand for modern household conveniences have given rise to the need for more and better housing facilities. To satisfy this need, it is imperative for more all to acquire the knowledge and skills needed in building construction. This premise has proven that the continuous growth in population of the country becomes the serious concerned not only by the government but also by all sectors in a society to provide a descent need for shelter to every people or family. It is then imperative to train students and other professionals in the field of construction to contribute to the development of this industry through innovation.

In the College of Industrial Technology at the Batangas State University, a university which is originally known as a trade school offers different courses in engineering and technology in order to meet the demands and challenges of the time. Civil Technology is one of the specializations being offered. The curriculum offering of this program provides the training that shall enable the students to perform the task associated with the field of Civil Engineering. The main objective of this program is to train men and women who are deeply concerned with the development of new technologies for global competitiveness. One of the employment opportunities of the graduates of this course is to work as laboratory technician in the material testing shops or laboratory.

In the field of construction, contractors, builders, and laborers are responsible in assuring the quality of the building. Some of the materials in construction are tested before its use. Structural engineers design and test the quality of the materials like concrete hollow blocks, reinforcement steel bars, class of concrete mixtures, and fine and coarse aggregates.

Materials Testing is performed for a variety of reasons and can provide a wealth of information about the tested materials, prototypes, or product samples. The data collected during testing and the final test results can be very useful to engineers, designers, production managers, and others. The many reasons why material testing is important are: meeting the requirements of regulatory agency; selecting appropriate materials and treatment for an application; evaluating product design or improvement specifications, and verifying a production process. In cases like these, governments and regulatory bodies set compliance requirements that must be met by manufacturers. Companies must adhere to these standards, which generally specify test procedures, to prove compliance (https://www.designingbuildings.co.uk/wiki/Construction_materials).

Materials are tested for diverse purposes: to determine the properties of the raw material, to check quality at intermediate stages in production processes, to check finished products, and to aid research. Mechanical, physical, and chemical methods are used to study the properties of materials. Destructive methods damage or completely destroy the object of the tests; nondestructive ones permit further use of the object.

Broadly, there are four types of tests. Mechanical methods test the material's ability to resist tension, compression, impact, bending, twisting, and shearing and its hardness and fatigue level (that is, its ability to withstand alternating mechanical loads without breaking). Physical tests determine electrical conductivity, heat conductivity, cold resistance, and magnetic and other properties. Chemical tests determine chemical composition and ability to withstand chemical action, especially oxidation. Structural tests (called metalomicrographic tests) determine the mac-restructure, or structure visible to the naked eye; themicrostructure, visible through a microscope; and the crystalline structure, determined primarily by X rays. Various technological samplings used to check the ability of a material to resist

deformation and the actions of temperature and chemicals or its machinability may also be considered testing of materials (The (Great Soviet Encyclopedia, 1970-1979).

In a material testing laboratory center, the process of sieve size analysis is through oven drying and washing the aggregates before testing it. A sieve analysis (or gradation test) is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material by allowing the material to pass through a series of sieves of progressively smaller mesh size and weighing the amount of material that is stopped by each sieve as a fraction of the whole mass. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common (https://en.wikipedia.org/wiki/Sieve_analysis).

The procedure of sieve size analysis includes cleaning and inspect the necessary screen for wet screening as indicated on the sizing work order; clean and prepare the filters pots with labeled filter paper; washing and weighing sample gently through required screen into a clean bucket, using cool tap water, gentle spray and your hands until water runs clean into bucket; filter the plus product remaining in the screen; place the filter paper in the oven to dry. Remove to cool. Filter and dry the minus product collected in the product (https://www.911metallurgist.com/blog/perform-test_sieves-analysis#wet-screening).

In washing aggregates, it is done either by manual process or with the use of aggregates washer. Aggregate Washers save time and effort associated with manual methods of washing aggregate samples. The Aggregate Washer gently agitates a sample while water supplied through an existing water line is fed into the bucket through the flexible nozzle until the aggregate and water mixture run clear, fines have been sufficiently removed from the sample (https://www.karolwarner.com/aggregate-washers).

The Sand Washer machine is used to wash off impurities like clay, silt, and other unwanted particles from sand to make it fit for use. This sand washer is specially designed to wash sand used in construction and make it comply with Indian Standard. The screening is done with the help of a wire mesh. Sand is conveyed and washed simultaneously by a paddle screw conveyor. The rotary bucket elevator scoops up the sand from the tub and on its way to delivery, drains water from sand. In this context, the objective of this work was to design the transmission system to drive the machine to maintain the output of washed sand at 6m3/hr (https://www.iosrjournals.org/iosrjmce/papers/RDME-Volume1/RDME-3.pdf)

Sand and gravel are siliceous and calcareous products of the weathering of rocks and unconsolidated or poorly consolidated materials. Grain shape, screen analysis, chemical characteristics, as well as thermal characteristics, must be uniform to get uniform properties in today's sand mixes. The process of developing a concept which has the capability to bring revolution in the field of construction in most developing nations. Sand screening and washing is being done for many centuries in the field of construction all around the world (http://internationaljournalcorner.com/index.php/ijird_ojs/article/view/133908)

In the article concerns research on washing effectiveness of a high-pressure washing device, three types of investigations were carried out: Laboratory tests on washing of crushed-stone and gravel aggregate, as well as pilot-scale tests on crushed-stone aggregate. Laboratory tests were conducted for four changeable parameters and pilot-scale investigations for three parameters. All tests were performed based on factorial experiment procedure. For each type of material there was built a model based on multiple regression

method. Results of investigations showed that operating pressure in the washer has the highest effect on obtained washing effectiveness, measured as a degree of dust impurities' removal from feed. The second parameter with the highest impact on washing process effectiveness was the maximum particle of feed, and its relationship to the obtained washing effectiveness appeared inversely proportional. For the crushed-stone aggregate the susceptibility of washing also appeared significant in models (https://agris.fao.org/agrissearch/search.do?recordID=US202100246138)

Removal of fine clay impurities is the most common method of mineral aggregates processing. Various washing devices operate with different effectiveness and capacities. The paper concerns the investigations of aggregate washing operations by using high-pressure washers. A comparative analysis of two types of washers, that is log washer and high-pressure washer, shows that the second device operates at much higher effectiveness measured through the percentage of removal of clay impurities. The energy consumption is also more favorable for the high-pressure washer (https://doi.org/10.1051/e3sconf/20160801041)

The paper compares macromechanical and micromechanical properties of high-performance concrete containing supplementary cementitious materials and basalt aggregate. The aggregate was either a common unprocessed crushed basalt aggregate or crushed basalt aggregate the coarse fractions (4/8 and 8/16 mm) of which were washed by water and dried before use. The observed macro-mechanical properties were compressive strength, tensile strength, elastic modulus and depth of penetration of water under pressure; the paper is focused on the first observed property, which is the basic material characteristic. On the microscale, the thickness of the interfacial transition zone (ITZ) was determined by nanoindentation. The positive influence of supplementary cementitious materials and aggregate washing on compressive strength was confirmed and the correlation between macromechanical and micromechanical characteristics was proved (https://doi.org/10.4028/www.scientific.net/SSP.309.26)

In the testing laboratory center, the sieve size analysis of a coarse aggregates is a very tedious process for laboratory technicians. The processes involve weighing, washing and drying the aggregates into the oven and screening the aggregates using the different sieve size screen before the actual analysis to determine if the aggregates is good or will passed the required standard by the public works and highways. As observed, the laboratory technician uses their bare hands in washing the aggregates and they spend more time and effort in doing this task. Washing the 5 kilos sample aggregates by bear hands will take a technician forty minutes. Some times their hands meet injured and by exposing their hand to water and heat it may also affect their health for having palsy hands.

Because of this situation, the researchers come up to develop an aggregates washer. The main purpose of this machine is to wash the aggregates before testing it. This machine will help laboratory technicians to make things easier, lessen effort and saving time. It is useful because it makes works faster and more convenient with more quantity and quality output. In this premise, the researcher thought of conceptualizing a design of improvised coarse aggregates washer for sieve size analysis to help laboratory centers make their task easier faster and safer. The design feature of this device is easier to comprehend and manipulate. Thus, this project is much safer to use, high level of accuracy and efficiency and makes the testing process of aggregates faster.

Objectives of the Study

The primary focus of this study was the development and construction of inclined coarse aggregates washer. Specifically, this study aimed to:

1. Design an inclined coarse aggregates washer,

2. Estimate the cost of supplies and materials needed in the construction of the project,
3. Construct the inclined coarse aggregates washer, and
4. Test and evaluate the functionality of the completed project.

II. METHODS

Research Design

This project development study aimed to design and construct an Inclined Coarse Aggregates Washer. In doing this, the researchers gathered relevant information about aggregates washer from different books, journals, and internet sources and from previously conducted similar local studies. The materials to be used in the construction of the project were listed and estimated and were secured from the local market. The tools and equipment available in the school shop were utilized and they sought the help of the machinist and welder for the assembly of some delicate parts. The proponent uses their own funds to buy the materials which mostly are bought from the junk shop. The concept of the study is presented in Figure 1 below.

III. INPUT PROCESS OUTPUT

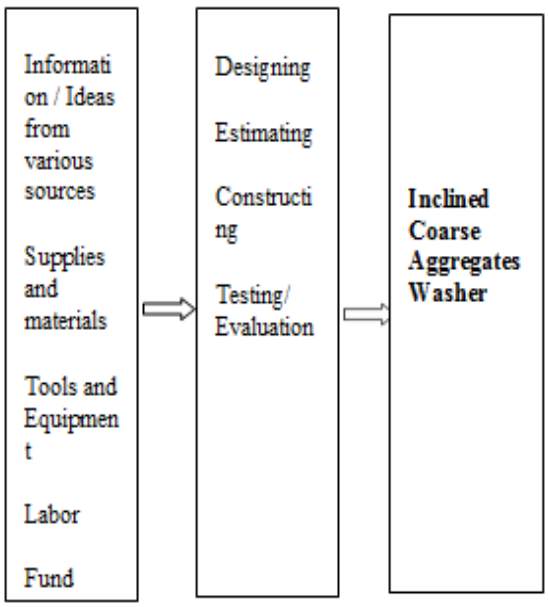

Figure 1. *Conceptual Paradigm of Tiltable Coarse Aggregates Washer*

After gathering all related information, they started conceptualizing this project design utilizing the Input-Process-Output model to give a clear arrangement of ideas up to the development of the project. The input refers to the information and ideas gathered by the researchers through different sources. Supplies and materials were carefully selected as well as the tools and equipment. High quality supplies and material were used to ensure durability and functionality. Tools and equipment were used according to their functions. The proponent tapped the help of the welder and machinist in assembling the mechanical aspect of the project. The processes used in making the device includes the designing, estimating, constructing and testing and evaluating the final output. In designing the full concept of the device, it includes the analysis on the limitation and capacity of each sub- part. The researchers went to different stores to canvass cheaper but in good quality materials. Procedures were followed based on the planned construction process. Testing and evaluation was done in order to come up with a functional device.

IV. RESULTS AND DISCUSSION

The results are organized and presented relative to the specific problem posed by the researcher.

Design Stage

The researcher conceptualized the design of the project taking into considerations of the materials to be used, the shape and its measurements. The information gathered from the pre-design stage were used and served as reference in designing the project. Ergonomics will be considered in designing the project hence its usefulness will be achieved. The ergonomically design project will allow us to strive to improve human and system performance, health, safety, comfort, and the quality of life. Sketching is the first step in designing the project. The researcher used the Auto Cad 2007 application when sketching the final design has finished.

Brief Description of the Drawings

Figures show the pictorial and orthographic

drawing of the project.

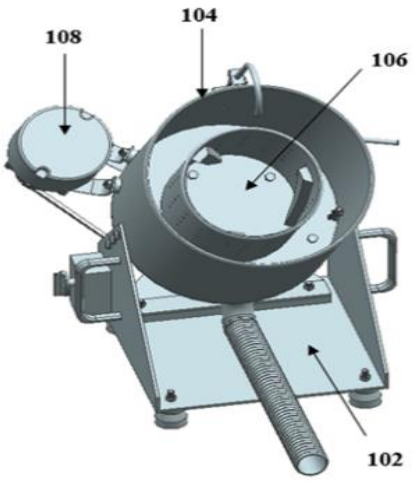

Figure 1: *Schematic representation of the isometric view of Inclined Coarse Aggregates Washer according to present invention.*

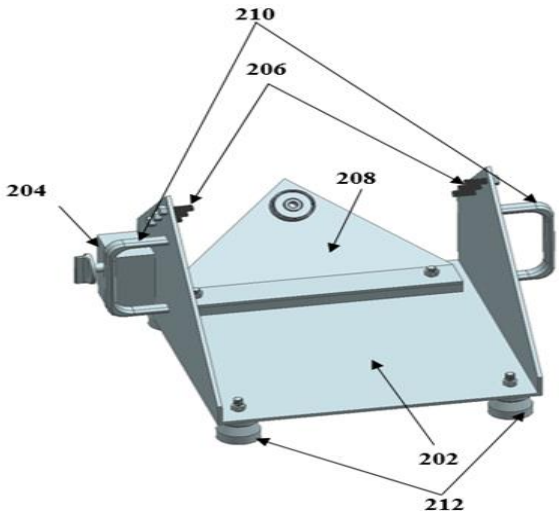

Figure 2: *Schematic view of the structure of the present invention, support unit.*

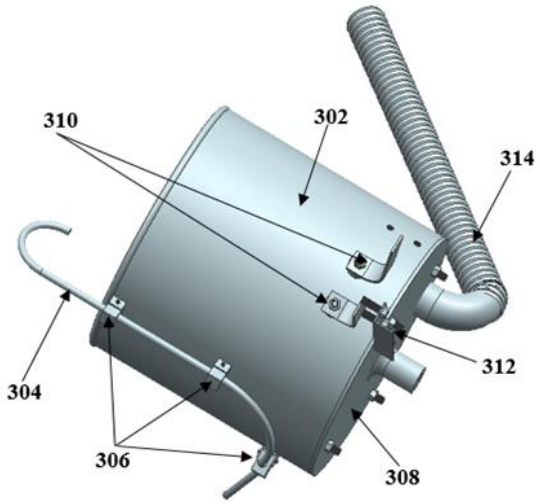

Figure 3:*Schematic view of the structure of the present invention, outer cylinder assembly.*

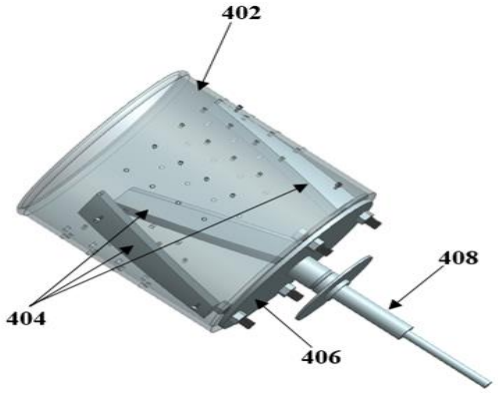

Figure 4:*Schematic view of the structure of the present invention, perforated inner cylinder assembly.*

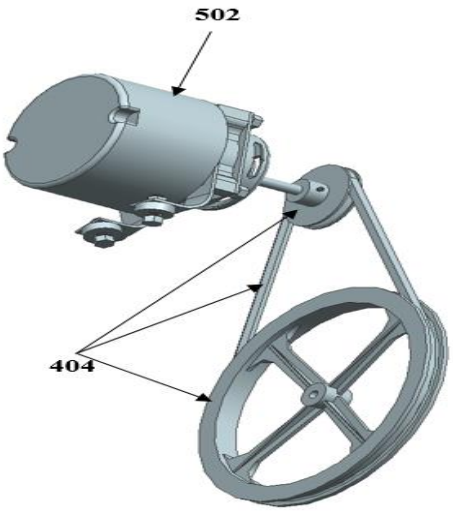

Figure 5: *Schematic view of the structure of the present invention, driving mechanism assembly.*

Cost of Supply and Materials

The researcher identified all the materials, tools and equipment needed to complete this project. The proponents went to different stores and hardware around Batangas and Manila to look for affordable yet quality supplies and materials need in this project. Some were source from junkshop and surplus store to look for other materials in partial quantity and sizes. The researchers made careful selection in choosing the best materials needed to complete this project. The financial component of the projects includes the supplies and materials, labor and miscellaneous expenses. The project was estimated to cost around Eighteen Thousand Pesos only which is very minimal and affordable.

Structure of the Project

The working drawing of the project serves as the basis in order to execute the fabrication stage. The correct measurement will be followed in the construction of the project in order to serve its purpose well.

The project is made up of four major parts which comprises support unit, outer cylinder assembly, perforated inner cylinder assembly, and driving mechanism assembly. The whole feature of this invention is made of mild steel plates and stainless-steel container that can stand stress and retain its strength capabilities for long term used.

The support unit 102 comprises of U-framework steel plate 202, control knob 204, positioning screws 206, angled plate 208, handle 210, and footings 212. This serve as the main foundation of other major assemblies which provides alignment, accuracy, stability, and reduction of vibration during the actual process of washing coarse aggregates, provide inclined capacity to the outer cylinder assembly 104 with the aid of positioning screws. The U-framework steel plate 202 served as the base and main foundation of other major assemblies which provides alignment, accuracy, stability as well as reduction of vibration during the actual process of washing of aggregates. The control knob 204 control the speed and duration of washing time of the coarse aggregates and it is mounted to the left inner most side of the U-framework steel plate 202. The positioning screws 206 allows the inclined position of the outer cylinder assembly during washing. The positioning screws 206 are located on both upper V-shaped portion of the U-framework steel plate 202 and this allows the outer cylinder assembly 104 to be position in an inclined position. The angle plate 208 is fastened on top of the back surface of the U-framework steel plate 202 and it contains bearing which guide and align the rotating shaft 408 as the driving mechanism assembly 108 rotates the perforated inner cylinder assembly 106 during washing of aggregates. The handle 210 is welded to both left and right outer side of the U-framework steel plate 202 allowing the machine to be carried easily in transferring from one location to another. The footing 202 is fastened to the four corners of the bottom surface of the U-framework steel plate and this is made of rubber and plastic allowing the reduction of vibration during washing and eliminating slippage movement to the unit during the process.

The plurality outer cylinder assembly 104 comprises of outer cylinder 302, water inlet 304, water inlet support bracket 306, bottom plate 308, upper motor support bracket 310, lower motor support bracket 312, and discharge pipe 314. This assembly provides stability and support to the perforated inner cylinder assembly 106 and driving mechanism unit and as well as serve as the outlet passage for the residue and water. The outer cylinder 302 is fastened on top of the bottom plate 308 which support the assembly of the perforated inner cylinder assembly and guide the centricity rotation of the rotating shaft 408. The said part 302 is also attached to the U-framework steel plate 202 in an inclined position using the positioning screws 206. The water inlet 304 is attached along the upper surface of the outer cylinder 302 in an inclined positioned using the water inlet support bracket 306 fastened to the outer cylinder. The said part 304 guides the flow of water rinsing the aggregates during the process of washing. The upper motor support bracket 310 is fastened to the circumference of the outer cylinder 302 to support the upper

portion of the driving mechanism 108. The lower motor support bracket 312 is fastened to both of the bottom surface of the bottom plate 308 and outer cylinder 302 which support the lower assembly of the driving mechanism 108. The discharge pipe 314 is located on the inner lower portion of the outer cylinder 302 in an inclined position. The said part 314 serves an outlet of discharge panel for dirt, residue, and water during washing process.

The plurality of the perforated inner cylinder assembly 106 comprises of perforated tank 402, plastic bar mixer 404, inner plate 406, and rotating shaft 408. This unit serve as container for the aggregates while rotating and mixing it with the help of plastic bar mixer 404. The of perforated tank 402 is attached to the inner plate 406 which is support by a rotating shaft 408 and driving mechanism 108 allowing the cleaning of the aggregates during washing. The plastic bar mixer 404 is fastened to the surface of the perforated tank allowing the aggregates to be mix during washing.

The driving mechanism assembly 108 comprises of an AC motor 502, and belt and pulley 504. This assembly is responsible for the rotation movement of the perforated inner cylinder assembly 106 during the washing process. The AC motor 502 is fastened to the lower area of the outer cylinder 302 with the aid of the upper motor support bracket 310 and lower motor support bracket 312. The belt and pulley 504 reduce the speed rotation of the rotating shaft 408 suitable for the washing of aggregates without damaging and reducing the actual size of the aggregates.

Fabrication of the Project

In this stage the construction of the project will commence. The working drawing of the project will be needed and will serve as the basis in order to execute the fabrication stage. The correct measurement will be followed in the construction of the project in order to serve its purpose well. Skills and expertise are required in the construction of the project hence, the researcher will look for a person who is expert in the welding and machining of parts and will commission him to construct the project.

Testing and Evaluation

In this stage, the project will be tested in order to evaluate the functionality and safety of the project. Likewise, evaluate if the project will serve its purpose well. The researcher used questionnaire and utilized by the experts, professionals, engineers, and students in the field of construction to assess and evaluate the project in terms of its functionality. The project was used by the randomly invited experts, professionals, engineers, architects and students based on their available time schedule. Afterwards, they were given questionnaire for them to answer faithfully based on their experienced using the project. The researcher was able to determine the functionality of the project since all the respondents exhibited positive response as to the functions of the project.

Questionnaire was used also by the researcher to know if the project is acceptable or not. The respondents were also the people who used and examined the project. Results showed positive and remarkable response in terms of acceptability of the project. With all the positive feedbacks of the respondents and other personalities regarding its functions, the project is significantly acceptable.

Since the project is carefully designed, health safety is being addressed for all users. The Structural framework was welded to be stabilized and prevent shaking or movement of the project. All sharped and pointed corners and edges were smoothened to prevent hazard. Moreover, after the testing and evaluation, the project is very safe to use.

V. CONCLUSION & RECOMMENDATION

Based on the analysis conducted, the researchers came up with the following findings: The project was designed and developed according to the purpose. This machine is a good substitute for the manual process in washing coarse aggregates in the material testing laboratory centers. The supplies

and materials used in the construction of this project were estimated at a very low cost because all were locally available in the market. The project was constructed through the utilization of different mechanical machinery such as milling machine, welding machine, lathe machine and other simple tools and equipment; The Inclined Coarse Aggregates Washer was tested and evaluated to determine its functionality. Based on the findings of the study, the concluded that the newly developed Inclined Coarse Aggregates Washer was designed to help the laboratory technicians. The production cost of the newly developed project was at a very minimal cost of Php 18,627.00. The machine was constructed based on the step-by-step procedures.

The machine was then found to be functional. It is highly recommended that this newly developed improvised machine be used in the material testing laboratory shops for commercial purposes and in the civil technology shops for instructional purposes. Business company for tools and equipment manufacturer must be commissioned to ensure the accuracy of the measurement and finish furnish of the project. Future researchers may conduct further study to add more features to the project development.

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