# Rebar Safety End Caps

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**Abstract: -** In construction projects, one of the most neglected injuries where the incidents from implanted rebar. Rebar impalement can prevent using rebar safety end caps. These caps can protect workers from being impaled or scratched by rebar. The materials were dominant in the construction industries in some countries. Consequently, the researchers want to develop while giving importance to the overseen incident in the construction industries here in the Philippines. The study addresses the matter by exploring what materials can be used as alternative materials to produce safety end caps. This study specifically aims to create Eco-friendly safety end caps rebar and develop the ideal design and mold. The compositions of eco-friendly products are the proportioning of selected materials that will be more economical than the existing product on the market. The researchers used decontaminated waste three ply-facemask as a primary material and conducted three samples with three different mixtures. a.) 100% pure facemask, b.) 70% facemask and 30% Polypropylene Containers, and c.) 70% facemask and 30% Plastic Cups. After some tests using the Drop Test and Impact Test, the 2nd sample composed of 70% facemasks and 30% Polypropylene Containers resulted in the most durable out of the three experimental sample mixtures.

**Key Words: —** ***Rebar End Caps, Eco-friendly Materials, Injuries, Construction, Waste Facemask.***

## I. INTRODUCTION

Safety is one of the most important factors to consider in construction work. As years goes by, the needs for infrastructure, housing, and commercial buildings grows gradually in connection with this the number of injuries and deaths in construction related accidents also goes up. As a result, to maintain a safe working environment in the construction industry, safety becomes one of the top priorities. To prevent the growing numbers of construction accidents, Safety procedures and protocols has been established so as to the use different construction safety equipment and gears.

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In early 2020, a new pandemic started to spread out which is COVID-19, While the world has prioritized countermeasures to contain the spread of the pandemic all over the globe, environmental concerns have been sidelined. Despite an overall reduction in waste, the amount of plastic and harmful micro-plastics has skyrocketed in the kingdom, with a weak pre-existing waste sorting and management system. Millions of face masks are disposed of on a daily basis. Tons of infectious waste are unable to be eliminated each day. This is what the "new normal" looks like amidst the COVID-19 pandemic. The type of infectious waste that has seen the highest surge during the pandemic is disposable masks, not only from hospitals and quarantine facilities but from households as well. Since the outbreak, its usage has become unavoidable, especially after wearing masks in public became mandatory. (Tierra K., 2021). As the researcher thinks of ways to help in lessening the environmental impact of this pandemic, the researcher thinks of ways to utilize pandemic waste as an alternative construction material. Face masks were the first placed as the major contributing pandemic waste known to have the same type of plastic which is Polypropylene, and the research ended up using

this to make a rebar cap as an alternative construction material in this research study.

In addition to the facemask, the researcher will also be using material that is Plastic Cups and Plastic Containers. They are both made from polypropylene which is why they are compatible to mix with the facemask. There are significant advantages of plastics like their durability, lightweight, and very cheap compared to other materials. Other types of plastics, like plastic cups, are not biodegradable and are extremely durable. Therefore, the majority of plastics manufactured today will continue for at least decades, and probably for centuries if not millennia.

Current studies are mostly stated that micro-plastics pollution should be a big deal because of its enormous effect on the entire environment. Identifying and addressing major difficulties in the construction business, as well as providing a number of solutions to work scenarios that affect project safety, is the purpose of this review study. As a result of a lack of understanding and awareness, a significant number of people die and suffer long-term injuries. Traditional construction safety management has encountered challenges as a result of the ever-increasing amount of information and data available. (Dr. Jayeshkumar P., and Chintan Shaileshbhai R., 2021)

Today, safety in steel bars during construction is a concern. Rebar or steel bar is one of the most needed materials in construction. It is used for reinforcing concrete structures and provides tensile strength that can support the concrete and makes it resilient. Steel reinforcing bars are a common safety hazard on construction sites. These steel bars can cut, scratch, pierce, and impale workers, which can result in serious internal injuries and death. To eliminate the hazard of impalement, rebar and other projections on a worksite should be guarded or covered.

The Occupational Health and Safety Administration has online records of injury reports dating back to 1984. A search of rebar impalement resulted in 61 incidents. The key findings from the search of the OSHA data yielded reported incidents involving rebar impalement resulting in death just over 26% of the time. 61 incidents, of which 16 were fatal. There is an average of 1.7 rebar impalement injuries reported to OSHA every year. It is 61 incidents over 36 years. (OSHA, 2020).
Rebar caps protect falling workers from impaling and scratching themselves on concrete rebar that is protruding during the construction process. The OSHA standard, 29 CFR 1926.701(b), states: “All protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the hazard of impalement.” CAL OSHA Construction Safety Orders Section 1712 covers the requirements for impalement protection. Our caps meet both standards for covering rebar, which states they must be capable of withstanding at least 250 pounds dropped from a height of ten feet. (OSHA, 1997).

### *1.1 Statement Of The Problem*

This study aims to create Eco-friendly Rebar Safety End Caps. This study will answer the following problems:

- What is the ideal design of the Eco-friendly Rebar Safety Caps and its mold?
- What will be the composition of the Eco-friendly Rebar Safety Caps?
- What is the best proportion of the materials used to make the Eco-friendly Rebar Safety Caps?
- Are the proposed safety rebar end caps more economical than the existing product on the market?
- Describe the Rebar Safety End Caps in terms of:
    - Drop Test
    - Impact Test

### *1.2 Significance of the Study*

This study aims to build a Rebar Safety End Caps that is made from Eco-Friendly materials.

*For the Industry:* The Rebar Safety End Caps would be able to help the industry of production by having an idea of how to create Eco-Friendly materials that can be released commercially in the future.

*For the Environment:* The Rebar Safety End Caps would be able to help to aid the growing environmental waste problems.

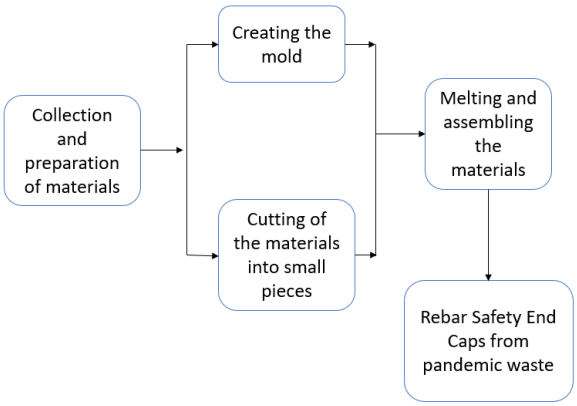
*For the Workers:* The Rebar Safety End Caps would be able to lessen the accidents involving exposed rebars encountered in Construction Projects.

*For the Future Researchers:* This study aims to give the researchers higher knowledge about this topic. These will also give additional understanding and information for the researchers in the future.

### 1.3 SCOPE AND DELIMITATION

This study covers only the production of Eco-Friendly Rebar Safety End Caps that would be used as impalement protection. The materials that were needed to create the Rebar Ends Caps came from areas of Cabanatuan City, Nueva Ecija. The Rebar Ends Caps were used to improve safety in Construction Projects.

### 1.4 CONCEPTUAL FRAMEWORK




### 1.5 DEFINITION OF TERMS

*Cal OSHA.* Agency of the Government of California established by the California Occupational Safety & Health Act of 1973. Administered by the California Department of Industrial Relations, Cal/OSHA's mission is to protect public health and safety through research and regulation related to hazards on the job in California workplaces.

*Drop Test.* Test of the strength of an object, in which it is dropped under standard conditions or a set weight is dropped on it from a given height.

*Impact Test.* Determines the material's toughness with the amount of energy applied during fracture.

*Impalement.* The act of pushing a sharp object through something, especially the body of an animal or person.

*OSHA.* The OSHA Standards were formulated in 1978 in compliance with the constitutional mandate to safeguard the worker's social and economic well-being as well as his physical safety and health. Adopted through the tested democratic machinery of tripartism, the 1978 Standards is considered as a landmark in Philippine labor and social legislation.

*Protruding.* To stick out from or throw something.

*Safety Rebar End Caps.* A plastic mushroom cap that provides protection from injuries.

## II. METHODS AND PROCEDURES

The study is experimental comparative research of the effectiveness of 3-ply facemasks when it melts and forms a rebar safety cap.

This chapter describes the methods and procedures of this study. This section consists of the Research Design, Locale of the Study, Research Instrument, Data Gathering, and Data Analysis and Technique.

### 2.1 Research Design

This study will use experimental research in which Rebar Safety Ends Caps will be made by an eco-friendly material. This study will consider the use of eco-friendly materials to make Rebar Safety End Caps through an experimental research design. The researchers will use the experimental research method to determine the possible outcome of the independent variables.

### 2.2 Locale of the Study

This research study will be conducted in Cabanatuan City, Nueva Ecija. The collection of used household 3-ply facemasks will be done in Barangay San Juan Accfa, Cabanatuan City.

### 2.3 Research Instrument

The researchers will use the following materials:

- Used household 3-ply facemask
- Polypropylene Containers
- Plastic Cups
- Metal Mold
- Rebar Safety Ends Caps

### 2.4 Data Gathering

The researchers will ask the Barangay Captain of San Juan Accfa to collect the community's used household 3-ply facemasks.

This chapter gives details to the materials and methods used in repurposing of 3-ply facemasks. The details of all ingredients of the product are well outlined. Also, discussed in this chapter

is the step-by-step process of making an eco-friendly rebar safety end cap.

### 2.5 Collection of Materials

*2.5.1 For the Collection of 3 ply-facemask*

According to the Brgy. Captain in San Juan Accfa, there is a separate truck for the collection of facemasks. They have 3 trashcans namely: Biodegradable, Non-biodegradable, and Facemasks. All this garbage will be collected by the private company of UNI-CORN Transport Services that is hired by the city and the facemasks will be disinfected at the Brgy. Valle Cruz dumpsite.

Mr. Jose Samonte Jr., the team leader of the Cabanatuan City Environment and Natural Resources Office (CCENRO), stated that the proper ratio of their disinfectant is 1:1. They used Bioenzyme and mixed it with the same amount of water and spray it into the used facemasks. And after 3 days, as per Mr. Samonte, the Metro Clark Waste Management Corp. will transport the garbage to their facilities in Capas, Tarlac.

*2.5.2 For the Collection of Polypropylene Containers*

For the collection of Polypropylene Containers, the researchers will collect used polypropylene containers from their households. Polypropylene containers can also be found in the recyclable trash bin. The city has no proper collection for the segregation of different types of recyclable plastics.

*2.5.3 For the Collection of Used Plastic Cups*

For the collection of plastic cups, the researchers will be using plastic cups that are commonly used for drinking. It can be collected mostly after occasions, stores that sell drinks, and other establishments that are using plastic cups. The plastic cups have no proper collection meaning it is mixed with other solid waste.

### 2.6 Preparation of the Materials and the Mold for melting

*2.6.1 Preparation of the 3-ply facemask*

The first thing to do is to wash the disinfected 3-ply facemask and let it dry for a day. Remove the nose clip and the garter. Then cut the 3-ply facemask into small pieces for it to melt faster. The average weight of a 3-ply-face mask is 2-3 grams. The 3-ply-facemask should weigh 80 grams for 1st sample, and 24 grams for 2nd and 3rd samples.

*2.6.2 Preparation of the Polypropylene Containers*

The polypropylene Containers must be clean and dry before cutting it into small pieces for them to melt faster.

*2.6.3 Preparation of the Plastic Cups*

The Plastic Cups must be clean and dry before cutting it into small pieces to melt faster. Refer to Table 1.0 for the ratio of each sample mixture.

Table 1.0 Ratio of the mixtures in grams.

| Mixture | 3-Ply Facemask | Other Material (grams) |
|---|---|---|
| 1st mixture | 100% (80g) | 0 |
| 2nd mixture | 70% (56g) | 30% (24g) Polypropylene Container |
| 3rd mixture | 70% (56g) | 30% (24g) Plastic Cups |

*2.6.4 Preparation of the mold*

The mold needs to be greased so that the melted 3-ply facemask won't stick. Petroleum Jelly will be used by the researchers because it is a suitable mold release agent for simple molds that do not have any fine details.

### 2.7 Preparation of The Sample

- Put the materials for every mixture into the heated pan and then wait for it to melt and stir it continuously until it fully melts. The melting point of polypropylene is between 160 to 180 degrees. The time needed to melt the mixture usually takes about 7 mins to 10 mins. When melting a 3-ply facemask or polypropylene it releases fumes that are mainly a mixture of paraffin waxes that were produced from the thermal degradation of polypropylene and some chemical compounds. These paraffin waxes are not severely harmful to people and the environment. The mixture includes low-molecular-weight paraffin.
- Pour the melted mixture into the mold slowly in circular motion until the mold is full and after the mold is full, it must be compacted by using the top cover.
- Wait for the melted mixture to set. It takes about 10-20 minutes to cool down and set.
- The locks of the mold need to be unlocked. Then the mold together with the Rebar Safety End Cap will be reheated for 3 mins to 5 mins so that the petroleum jelly will melt which makes it easy to remove it from Rebar Safety End Cap mold.

Testing the sample

1. Drop test
2. Impact Test

### *2.8 Schematic diagram of the mold*

*Top Cover* – Metal ring and used washers

*Base* – Used metal plate that has the dimensions 150mmx75mmx10mm

*Cylinder* – Used Metal Cylinder that has a dimension of 35mmx82mm

*Cylinder lock* – Used round clamp and welded piece of metal as handle

*Middle Cylinder* – Used Dowel that has a dimension of 19mmx60mm

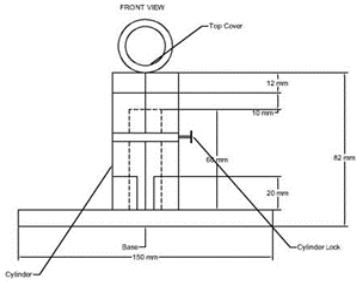



Fig.1.0 Front view of the mold

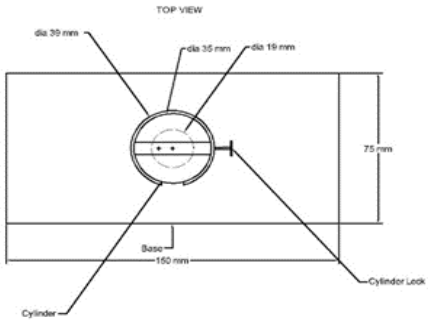



Fig.1.1 Top view of the mold

Fig.1.2 3D Model of the mold

### *2.9 Data Analysis and Technique*

The data gathered by the researcher will be compiled, sort out, and organize. They will be subjected to statistical treatment to answer the specific problems of the study.

In this study, several tests and experiments will be taken to obtain the desired output of the study.

### *2.10 Test*

*2.10.1 Drop Test*

Rebar Safety End Caps will be dropped from the height of 5.38 m, 9.38m, and 13.38m meters.

*2.10.2 Impact Test*

Rebar Safety End Caps will receive a force or weight (2.565 grams) from the height of 1.5 meters.

## III. PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

Based on the conducted experimentation for the following mixture, data and results were presented as follows;

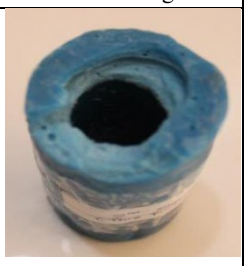
| Test | Drop Test<br>H = 13.38 m | Impact Test<br>H = 1.50 m<br>w = 2.565 kg |
|---|---|---|
| 1st sample |  |  |
| 2nd sample |  |  |
| 3rd sample |  |  |

Fig.2.0 Drop test and Impact test on the sample

Table.2.0 Results of Drop Test and Impact Test

| Sample | Drop Test | | | Impact Test |
|---|---|---|---|---|
| | 2nd Floor 5.38 m | 3rd Floor 9.38 m | 4th Floor 13.38 m | 1.50 m |
| 1st sample | ✓ | ⊗ | × | × |
| 2nd sample | ✓ | ✓ | × | × |
| 3rd sample | ✓ | ⊗ | × | × |

✓ - Undamaged

⊗ - Fragmented

× - Damaged

Based on table 2.0, all samples broke after the drop test from the height of 13.38 meters. The 1st sample, it just broke a small piece at the 9.38-meter mark.

A drop test with an object of 2.565 kg hit the samples at a height 1.5 meters, all samples have the same results. The samples broke in the same section which is the base.

Based on the several tests conducted, the 2nd mixture that is 70% 3 ply-facemask and 30% polypropylene containers appears to be the most durable, strongest and compacted among the three (3) samples.

### *3.1 Cost Analysis*

*3.1.1 Rebar Safety End Caps*

3ply-Facemask - 0 php
Plastic Cups - 0 php
Polypropylene Container - 0 php
Petroleum Jelly – 41 php
Charcoal – 60 php
No. of Rebar Safety End Caps made: 9 pcs
Each Rebar Safety End Cap will cost 11.22 php

*3.1.2 Rebar Safety End Caps (From Market)*

55 php each

Based on the prices compared the Rebar Safety End Cap will be cheaper by 43.78 php than the Rebar Safety End Cap From the market.

## IV. SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents a general overview of the entire study that serves as the basis for conclusions and recommendations. This includes the summary, conclusions, and recommendations.

### *4.1 Summary*

Rebar Safety End Caps are produced with eco-friendly materials. 3-ply-facemask, Polypropylene Containers, and Plastic Cups are used to make Rebar Safety End Caps. It has a dimension of ⌀= 19mm, Tc= 8 mm, H=70 mm, Tb= 10mm. The researchers used 3 different mixtures of the said materials. The 1st sample is the 100% 3-ply Facemask, 2nd sample is 70% 3-ply facemask and 30% Polypropylene Containers, 3rd is 70% 3-ply facemask and 30% Plastic Cups. The samples were subjected to a Drop test with a height of 13.38 m and an Impact test with an object weighing 2.565 kg.

### *4.2 Conclusion*

The researchers concluded that the ideal Rebar Safety End Caps design for this study has a dimension of ⌀= 19mm, Tc= 8 mm, H=70 mm, Tb= 10mm, and the mold is customized for the consistency in producing the Rebar Safety End Caps because it is only the preliminary research in producing Rebar Safety End Caps with eco-friendly materials and also for the researchers to produce in such a limited time. The best ratio for the composition of the Rebar Safety End Caps is the 2nd Sample, 70% 3-ply-facemask, and 30% Polypropylene Containers. Out of all the samples, 2nd sample came out to be the strongest and most compacted sample of Rebar Safety End Caps. The proposed Rebar Safety End Caps is more economical than the existing product on the market based on the estimated cost analysis the proposed Rebar Safety End Caps is 11.22 php which can start to produce multiple numbers of Rebar Safety End Caps. While the End Cap from the market is worth 55 php per piece.

As a result of the tests done to the samples, the researchers concluded that the 2nd sample is more durable and stronger.

*Recommendation:*

Based on this study, a 3-ply facemask can be used to be a primary material to make a Rebar Safety End Cap. The proportions of the primary and secondary material used in this study is 70%-30%. Due to the limited time, the researchers could not try other proportions, different designs of the Rebar Safety End Caps, its mold, and also the researchers could not try other economical materials.

The following recommendations are at this moment formulated from the summary and conclusions. Explore the design and other proportions of the materials. May consider different secondary materials for the sample mixture and the inclusion of fins inside the caps. Design and fabricate a better mold to maintain the thickness desired in the sample. Propose proper segregation for the different types of recycled plastic. Grind the sample to melt faster and subject to test advice by an expert concerning health hazards.

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