FACULTY OF ENGINEERING

DEPARTMENT OF WATER RESOURCES ENGINEERING

DESIGN AND CONSTRUCTION OF A COST-EFFECTIVE 3D EXTRUSION BASED CONCRETE PRINTER

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ABSTRACT.

For the past twenty years, the world's population has increased from 6.1 billion to 7.8Billion and this has led to urgent need for construction to provide shelter for this population. With the increasing outbreak of disasters such as wars, floods, earthquakes, hurricanes among others, there has been damage on the existing houses causing an increase in the refuge population around the world being. 3D concrete printing is an innovative construction method that is very advantageous in the construction field in terms of optimizing construction time, cost, design flexibility, error reduction, and environmental aspects. Some companies came up technologies include modular construction, construction exoskeleton, construction robots, Building Information Modelling and 3D printing.

Concrete is extruded through a nozzle to build structural components layer-by-layer without the use of formwork or any subsequent vibration. When a layer has been 3D printed, fast re-building of the static yield stress is required to retain the printed shape despite self-weight and that of upper layers

The contribution of this study is to identify and resolve the various design and operational constraints of 3D concrete printing, which are of vital importance for future development of this construction technology.

Experimental results are presented concerning the tests performed to determine the behaviour of the printed concrete and the one from conventional methods of construction.

This study therefore aims at designing the printing machine and the result is the a prototype of the cost effective 3d extrusion based concrete printer with automated concrete mixer.

Declaration

I **ATUKUNDA EVA, KAWALYA DOUGLAS, MAWEL DAVID AYUEN AND MUSIIMENTA CHARITY** declare that all the material portrayed in this project proposal report is original and has never been submitted in for award of any Degree, certificate, or diploma to any university or institution of higher learning.

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Approval

This is to certify that the project report under the title "DESIGN AND CONSTRUCTION OF A COST-EFFECTIVE 3D EXTRUSION BASED CONCRETE PRINTER." has been done under my guidance and supervision and is now ready for examination.

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List Of Abbreviations

3D	Three Dimensions
CNC	Computer Numerical Control
CAD	Computer Aided Design
STL	Stereo lithology File Format
DIY	Do it yourself
PLM	Project life Management
Rpm	Revolutions Per Minute
LCD	Liquid Crystal Display
AC	Alternating Current
DC	Direct Current
IDE	Integrated Development Environment
ASTM	American Society for Testing and Materials.
UNHCR	United Nations High Commissioner for Refugee
SDG	Sustainable Development Goal
NPV	Net Present Value
P. I	Probability Index
BIM	Building Information Modelling

1 CHAPTER ONE: INTRODUCTION

This chapter gives a summary on the background of the research area. The problem, its causes and the associated effects.it also clearly identifies the existing solution gaps and objectives done to solve the problem.

1.1 Background

The need for construction has increased due to the world's growing population. For the past twenty years, the world's population has increased from 6.1 billion as of 2000 to 7.8Billion in 2020.(Roser & Ortiz-Ospina, 2017). With the increasing outbreak of disasters such as wars, floods, earthquakes, hurricanes among others, there has been damage on the existing houses causing an increase in the refuge population around the world being 21792668 people in 2022(UNHCR, 2022) .Africa being the second largest populated continent second to Asia has a refuge population of about 30% of the world's population((Adesina et al., 2021). By the end of 2021,East Africa hosted 4.9 millions of refuge(Adesina et al., 2021)and in Uganda refugee population has increased from 31.8% in 2010 to 60.3% in 2015 then to 80.4%in 2019 and 84.9% in 2020 (Population & Sheet, 2020)which requires an immediate intervention by constructing houses to accommodate homeless people.

Construction companies all over the world have come up to provide accommodation to the growing population. This however has not been fully achieved due to longer construction periods in the construction industry and relatively high construction costs due to the extra cost incurred in hiring a number of both skilled and unskilled workers at the construction site. In most traditional economies. countries today, labour shortage is being experienced and in most cases work is done by 21% of workers who are greater than 55 years which slows down work progress and increases accidents at construction site (Ngobi et al., 2021).

The novelties in emerging technologies include modular construction, construction exoskeleton, construction robots, Building Information Modelling and 3D printing. Modular construction involves joining of pre-cast elements of the structure using a crane system at site. It however involves transportation of the building elements to the site which may lead to damages along the way and extra transport costs hence limiting its adoption. According to (Roser & Ortiz-Ospina,

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