

**PROPOSED DESIGN OF A PROTOTYPE  
MULTI-LEVEL AQUAPONICS FARM  
IN PULILAN, BULACAN**

**Design Project**

**JOHN MARK A. DULFO  
EDYCHRIS E. RIVERA**

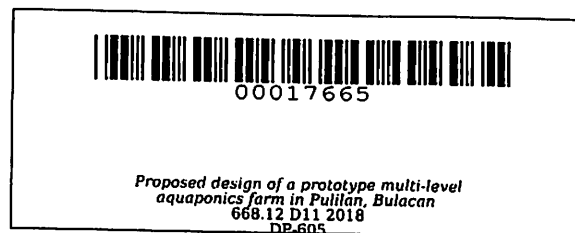
**College of Engineering and Information Technology  
CAVITE STATE UNIVERSITY  
Indang, Cavite**

**June 2018**

# **PROPOSED DESIGN OF A PROTOTYPE MULTI-LEVEL AQUAPONICS FARM IN PULILAN, BULACAN**

Undergraduate Design Project  
Submitted to the Faculty of the  
College of Engineering and Information Technology  
Cavite State University  
Indang, Cavite

In partial fulfillment  
of the requirements for the degree  
Bachelor of Science in Civil Engineering



**JOHN MARK A. DULFO**  
**EDYCHRIS E. RIVERA**

June 2018

## ABSTRACT

**DULFO, JOHN MARK A. and RIVERA, EDYCHRIS E. Proposed Design of a Prototype Multi-Level Aquaponics Farm in Pulilan, Bulacan.** Undergraduate Design Project. Bachelor of Science in Civil Engineering, Cavite state University, Indang, Cavite. June 2018. Adviser: Engr. Cene M. Bago.

The study entitled “Proposed Design of a Prototype Multi-Level Aquaponics Farm in Pulilan, Bulacan” was conducted at Cavite State University – Main Campus.

Rice is considered as the most important food crop in the Philippines. It is the main staple food in the country. However, the rice production of the country still cannot accommodate its demand. A recent study entitled “Cultivar: A Proposed Prototype Multi-Level Rice-Fish Aquaponics Farm” by Rivera, E. E. (2016) aimed to increase the rice production through vertical farming which maximizes the use of land for rice farming. This inspired the authors to design a multi-level aquaponics farm that could primarily produce rice, and also capable of producing other farm crops. The main objective of the study was to design the structural plan for the prototype multi-level rice and fish aquaponics farm. The structure is a reinforced concrete designed, three-storey building with a roof deck. It has a total floor area of 1,512 square meters. The total cost estimate of the project was P43,242,495.25. The study provided the architectural plan, structural plan, electrical and plumbing layout and detailed cost estimate and specifications of the proposed project. The sizes of structural members were designed based on the maximum forces and moments obtained from the 2D STAAD analysis. The authors recommend the use of innovative architectural and structural concepts to lessen the impact of internal and external forces on the structure. The actual soil bearing capacity of the site in Pulilan, Bulacan was recommended to be used for further developments based on this study.

## TABLE OF CONTENTS

|                                           | Page        |
|-------------------------------------------|-------------|
| <b>APPROVAL SHEET .....</b>               | <b>ii</b>   |
| <b>BIOGRAPHICAL DATA .....</b>            | <b>iii</b>  |
| <b>ACKNOWLEDGMENT .....</b>               | <b>v</b>    |
| <b>PERSONAL ACKNOWLEDGMENT.....</b>       | <b>vi</b>   |
| <b>ABSTRACT .....</b>                     | <b>viii</b> |
| <b>LIST OF TABLES .....</b>               | <b>xi</b>   |
| <b>LIST OF APPENDIX TABLES .....</b>      | <b>xii</b>  |
| <b>LIST OF APPENDIX FIGURES .....</b>     | <b>xiii</b> |
| <b>LIST OF APPENDICES .....</b>           | <b>xvi</b>  |
| <b>INTRODUCTION.....</b>                  | <b>1</b>    |
| Statement of the Problem.....             | 2           |
| Objectives of the Study .....             | 2           |
| Significance of the Study .....           | 3           |
| Scope and Limitation of the Study.....    | 3           |
| Time and Place of the Study .....         | 3           |
| Definition of Terms.....                  | 4           |
| <b>REVIEW OF RELATED LITERATURE .....</b> | <b>6</b>    |
| <b>METHODOLOGY .....</b>                  | <b>14</b>   |
| Data Gathering .....                      | 14          |
| Development of Plans and Layouts .....    | 14          |
| Preparation of STAAD Data.....            | 14          |

|                                                    |           |
|----------------------------------------------------|-----------|
| Design Computations and Analysis .....             | 15        |
| Cost Estimate .....                                | 34        |
| <b>RESULTS AND DISCUSSION .....</b>                | <b>35</b> |
| Data Gathering .....                               | 35        |
| Development of Plans and Layouts .....             | 36        |
| Preparation of STAAD Data.....                     | 36        |
| Design Computations and Analysis .....             | 36        |
| Cost Estimate .....                                | 38        |
| <b>SUMMARY, CONCLUSION AND RECOMMENDATION.....</b> | <b>39</b> |
| Summary .....                                      | 39        |
| Conclusion .....                                   | 40        |
| Recommendations.....                               | 41        |
| <b>REFERENCES.....</b>                             | <b>42</b> |
| <b>APPENDICES.....</b>                             | <b>44</b> |

## LIST OF TABLES

| Table                                                        | Page |
|--------------------------------------------------------------|------|
| 1 Coefficients for negative moments in slabs .....           | 16   |
| 2 Coefficients for dead load positive moments in slabs ..... | 16   |
| 3 Coefficients for live load positive moments in slabs ..... | 17   |

## LIST OF APPENDIX TABLES

| <b>Appendix<br/>Table</b> |                                                                       | <b>Page</b> |
|---------------------------|-----------------------------------------------------------------------|-------------|
| 1                         | Load combinations.....                                                | 202         |
| 2                         | Aquaponics loads .....                                                | 202         |
| 3                         | Seismic considerations .....                                          | 202         |
| 4                         | Allowable soil pressure .....                                         | 203         |
| 5                         | Steel reinforcement information .....                                 | 204         |
| 6                         | Quantity of lumber for scaffolding or staging .....                   | 204         |
| 7                         | Concrete proportions .....                                            | 204         |
| 8                         | Quantity of cement and sand for mortar and plaster in cu. meter ..... | 205         |
| 9                         | Quantity of cement and sand for CHB mortar per square meter .....     | 205         |
| 10                        | Length of reinforcing bars for CHB in meters .....                    | 205         |
| 11                        | No. 16 G.I. tie wire for CHB reinforcement per square meter .....     | 206         |

## LIST OF APPENDIX FIGURES

| Appendix<br>Figure                     | Page |
|----------------------------------------|------|
| 1 Vicinity map.....                    | 46   |
| 2 Site development map .....           | 47   |
| 3 Perspective .....                    | 48   |
| 4 Ground floor plan.....               | 49   |
| 5 Second floor plan .....              | 50   |
| 6 Third floor plan .....               | 51   |
| 7 Roof deck plan .....                 | 52   |
| 8 Roof plan.....                       | 53   |
| 9 Front elevation .....                | 54   |
| 10 Rear elevation .....                | 55   |
| 11 Left side elevation.....            | 56   |
| 12 Right side elevation.....           | 57   |
| 13 Longitudinal section thru “X” ..... | 58   |
| 14 Cross section thru “Y” .....        | 59   |
| 15 Schedule of doors and window .....  | 60   |
| 16 Structural frame A.....             | 62   |
| 17 Structural frame B.....             | 63   |
| 18 Foundation plan .....               | 64   |
| 19 Second floor beam plan .....        | 65   |
| 20 Third floor beam plan .....         | 66   |

|    |                                      |    |
|----|--------------------------------------|----|
| 21 | Roof deck beam plan .....            | 67 |
| 22 | Details of two way slab 1 .....      | 68 |
| 23 | Details of two way slab 2.....       | 69 |
| 24 | Details of slab on grade.....        | 70 |
| 25 | Details of stairway .....            | 71 |
| 26 | Details of ramp.....                 | 72 |
| 27 | Details of beams 1 and 2 .....       | 73 |
| 28 | Details of beams 3.....              | 74 |
| 29 | Schedule of beams .....              | 75 |
| 30 | Details of square column .....       | 76 |
| 31 | Details of isolated footing 1 .....  | 77 |
| 32 | Details of isolated footing 2.....   | 78 |
| 33 | Ground floor lighting layout .....   | 80 |
| 34 | Second floor lighting layout.....    | 81 |
| 35 | Third floor lighting layout .....    | 82 |
| 36 | Roof deck lighting layout.....       | 83 |
| 37 | Ground floor power layout.....       | 84 |
| 38 | Second floor power layout.....       | 85 |
| 39 | Third floor power layout.....        | 86 |
| 40 | Roof deck power layout.....          | 87 |
| 41 | Electrical legend.....               | 88 |
| 42 | Ground floor water line layout.....  | 90 |
| 43 | Second floor water line layout ..... | 91 |

|    |                                                    |    |
|----|----------------------------------------------------|----|
| 44 | Third floor water line layout .....                | 92 |
| 45 | Roof deck water line layout .....                  | 93 |
| 46 | Ground floor sewage and drainage line layout ..... | 94 |
| 47 | Second floor sewage and drainage line layout.....  | 95 |
| 48 | Third floor sewage and drainage line layout.....   | 96 |
| 49 | Roof deck sewage and drainage line layout.....     | 97 |
| 50 | Plumbing legend .....                              | 98 |

## LIST OF APPENDICES

| Appendix |                             | Page |
|----------|-----------------------------|------|
| 1        | Architectural plans.....    | 45   |
| 2        | Structural plans .....      | 61   |
| 3        | Electrical layouts.....     | 79   |
| 4        | Plumbing layouts .....      | 89   |
| 5        | Design computations.....    | 99   |
| 6        | List of tables.....         | 201  |
| 7        | STAAD Analysis results..... | 207  |
| 8        | Cost estimate.....          | 210  |

# **PROPOSED DESIGN OF A PROTOTYPE MULTI-LEVEL AQUAPONICS FARM IN PULILAN, BULACAN**

**John Mark A. Dulfo**  
**Edychris E. Rivera**

---

An undergraduate design project submitted to the faculty of the Department of Civil Engineering, College of Engineering and Information Technology, Cavite State University, Indang, Cavite, in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering with Contribution No. CEIT-2017-18-2-\_\_\_\_. Prepared under the supervision of Engr. Cene M. Bago.

---

## **INTRODUCTION**

Rice is considered as the most important food crop in the Philippines. It is the main staple food in the country. Half of the population in the Philippines was roughly calculated consuming rice. Since majority of the Filipinos consume rice on a daily basis, rice is embedded in the Philippine history and culture.

Rice is well-suited in the Philippines, a tropical country that is surrounded by water. However, the rice production of the country still cannot accommodate its demand. The three main factors that cause insufficiency of rice production in the Philippines are: population growth, urbanization of farm lands, and the process of rice product transportation. Given these factors, the production of rice should be increased by increasing the rice fields while consuming less land area. Also, the rice fields should be located near market areas to lessen transportation losses. With all these considerations, a study of a prototype multi-level rice and fish aquaponics farm was conducted.