

بسم الله الرحمن الرحيم



**Palestine Polytechnic University**

**Collage of Engineering & Technology**

**Civil and Architectural Engineering Department**

**Structure Engineering**

**Graduation Project**

**Project Title :**

**Structural And Environmental Design, a study of using green roofs  
system in construction.**

**Palestine – Hebron**

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دائرة الهندسة المدنية والمعمارية

هندسة مباني وهندسة بيئة

مشروع التخرج

التصميم الإنشائي والبيئي، دراسة استخدام الأسطح الخضراء في المنشآت

فريق العمل

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بناء على توجيهات الأستاذ المشرف على المشروع وبموافقة جميع أعضاء اللجنة الممتحنة، تم تقديم هذا المشروع إلى دائرة الهندسة المدنية والمعمارية في كلية الهندسة والتكنولوجيا للوفاء بمتطلبات الدائرة لدرجة البكالوريوس.

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## الإهداء

إلى القدوة الذين كانوا معنا في كل خطواتنا

إلى من زرعوا في داخلنا فكرة الحلم

من قدموا من أجل أن يرونا هنا حيث وصلنا

إلى فخرنا الذين نتكى عليهم في كل المرات التي نكون بحاجة إلى سند ونحن نثق أنهم لن يخذلونا يوماً

إليكم آبائنا

إلى أولئك العظيمات اللواتي يبتدئ عندهن الكلام ولا يعرف النهايات

إلى من آمنّ بقدراتنا على الوصول

إلى أمهاتنا اللواتي يتجه الحب والامتنان لهن

إلى صانعات الأمم اللواتي من تحت أقدامهن وجدت الجنة

إلى من كنّ وراء كل إنجازاتنا

إلى من وقفن بروحهن ودعائهن معنا في كل لحظات حياتنا

إليكن أمهاتنا

إلى أهلنا أصدقائنا وكل من كانت له يد في إتمام أحلامنا

وإلى كل من علمنا حرفاً وأهدانا فكرة

إليهم جميعاً

نهدي عملنا المتواضع راجيات من المولى عز وجل أن يجد عليه بالقبول والنجاح.

فريق العمل

## شكر وتقدير

"كن عالما .. فإن لم تستطع فكن متعلما ، فإن لم تستطع فأحب العلماء ،فإن لم تستطع فلا تبغضهم"

بعد رحلة طويلة من جهد و اجتهاد تكلفت بإنجاز هذا المشروع ، نحمد الله عز وجل على نعمه التي من بها علينا

فهو العلي القدير

كما لا يسعنا إلا أن نخص بأسمى عبارات الشكر و التقدير الدكتور "بلال المصري" لما قدمه لنا من جهد و نصح

و معرفة طيلة انجاز هذا المشروع

كما نتقدم بالشكر الجزيل لكل مكان وإنسان أسهم في تقديم علمه لنا، و نخص بالذكر جامعتنا العزيزة جامعة

بوليتكنك فلسطين، وإلى كلية الهندسة والتكنولوجيا. وإلى دائرة الهندسة المدنية والمعمارية، بطاقمها التدريسي و

الإداري

و إلى الذين كانوا عوناً لنا في إنجازنا هذا ونوراً يضيء الظلمة التي كانت تقف أحيانا في طريقنا .إلى من زرعوا

التفاؤل في دربنا وقدموا لنا المساعدات والتسهيلات والمعلومات ، فلهم منا كل الشكر

أما الشكر الذي من النوع الخاص فنحن نتوجه بالشكر أيضا إلى كل من لم يقف إلى جانبنا ، ومن وقف في طريقنا

وعرقل مسيرتنا فلولا وجودهم لما أحسسنا بمتعة العمل و حلاوة العمل، و لما وصلنا إلى ما وصلنا إليه فلهم منا

كل الشكر...

فريق العمل

## **Abstract**

### **Structural And Environmental Design, a study of using green roofs system in construction.**

Green or sustainable architecture considered as one of the new directions of architectural thinking which is interested in the relationship between the environment and the building. So, it meets the present needs without omission of the future needs of the next generations, and it contributes to decrease the effect of buildings on environment, also decrease the buildup and working costs , so, it is a high quality system meets the surrounding environment with the least side effects. It is an invitation to better deal with our environment.

Our building consists of a basement floor consisting of a garage, a ground floor consisting of shops, and two residential floors repeated three times with a total area of (9113) m<sup>2</sup>.

The project contains a detailed structural study, analysis of the structural elements, different expected loads, the structural design of these elements, and preparing the executive plans according to the existing design for all structural elements which forms the structural frame of the building. And from the environmental side the concentration was on the green roofs, that provide ecosystem services in urban areas, including improved storm-water management, better regulation of building temperatures, reduced urban heat-island effects, and increased urban wildlife habitat.

There was a meeting point between the environmental and structural section of the work in terms of loads. The expected load was calculated from the addition of the Green Roof. Dead and live loads were increased due to green roofs weight and systems. so, we had to use special structural system so the solid slabs were used under green surfaces, and it keeps the structural cost in reasonable limits.

All architectural and structural plans for the building were prepared. It was drawn with a three-dimensional technique. The distribution of the green surfaces was shown in the building, and attached with the project.

**Key words: structural design, green roof, green building, environmental study.**

God grants success

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## List of Abbreviations

- $A_c$  = area of concrete section resisting shear transfer.
- $A_s$  = area of non-prestressed tension reinforcement.
- $A_{s\bar{\circ}}$  = area of non-prestressed compression reinforcement.
- $A_g$  = gross area of section.
- $A_v$  = area of shear reinforcement within a distance (S).
- $A_t$  = area of one leg of a closed stirrup resisting tension within a (S).
- $b$  = width of compression face of member.
- $b_w$  = web width, or diameter of circular section.
- $C_c$  = compression resultant of concrete section.
- $C_s$  = compression resultant of compression steel.
- DL = dead loads.
- $d$  = distance from extreme compression fiber to centroid of tension reinforcement.
- $E_c$  = modulus of elasticity of concrete.
- $f_{c\bar{\circ}}$  = compression strength of concrete .
- $f_y$  = specified yield strength of non-prestressed reinforcement.
- $h$  = overall thickness of member.
- $L_n$  = length of clear span in long direction of two- way construction, measured face-to-face of supports in slabs without beams and face to face of beam or other supports in other cases.

- LL = live loads.
- Lw = length of wall.
- M = bending moment.
- Mu = factored moment at section.
- Mn = nominal moment.
- Pn = nominal axial load.
- Pu = factored axial load.
- S = Spacing of shear in direction parallel to longitudinal reinforcement.
- Vc = nominal shear strength provided by concrete.
- Vn = nominal shear stress.
- Vs = nominal shear strength provided by shear reinforcement.
- Vu = factored shear force at section.
- Wc = weight of concrete.
- W = width of beam or rib.
- Wu = factored load per unit area.
- $\Phi$  = strength reduction factor.
- $\epsilon_c$  = compression strain of concrete = 0.003.
- $\epsilon_s$  = strain of tension steel.
- $\epsilon'_s$  = strain of compression steel.
- $\rho$  = ratio of steel area.
- ASHRAE: American Society of Heating and Air-Conditioning Engineers (U.S1894).
- EPA :Environmental Protection Agency .
- GB Tool: Green Building Tool (Canada, 2002).
- LEED-NC: Leadership in Energy and Environment Design for New Construction and Major Renovations (U.S., 2000).
- No2 : Nitrogen dioxide.

- PMV : Predicted mean vote .
- PPD : Predicted percentage dissatisfied.
- PM10 : Particular matter.
- USGBC: United States Green Building Council.
- VOC : Volatile organic compound.
- WGBC : World green building council.