شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HANAA ALY

Faculty of Engineering
Public Works Department

"Investigation on the Manufacturing, Installing and Maintenance Management of Prestressed Monoblock Concrete Sleeper in Egypt Railway Network"

A Thesis Submitted in partial Fulfillment of the Requirement for

Doctor of Philosophy Degree

By

Eng. Mohamed Youssef Mohsen Youssef

B.Sc. Civil Engineering – Higher Technological Institute (2006)
M.Sc. Civil Engineering – Public works – Ain Shams University (2013)
Assistant Lecturer – Faculty of Engineering – Beni-Suef University

Supervised by

Dr. Amr Ali Abd Al Rahman
Professor of RC Structures
Structure Department - Faculty of Engineering - Ain Shams University

Dr. Hany Sobhy Riad
Associate Professor of Railway Engineering
Public Works Department - Faculty of Engineering - Ain Shams University

Dr. Hany Ibrahim Ahmed
Associate Professor of Properties & Strength of Materials
Faculty of Engineering – Beni-Suef University

Dr. Mohamed Maher Tawfik
Lecturer of Geotechnical & Foundation Engineering
Structure Department - Faculty of Engineering - Ain Shams University

2020
Cairo - Egypt

"Investigation on the Manufacturing, Installing and Maintenance Management of Prestressed Monoblock Concrete Sleeper in Egypt Railway Network''

By

Eng. Mohamed Youssef Mohsen Youssef

A Thesis Submitted in the partial Fulfillment of the
Ph.D. Degree

Examiners Committee

Name	**Signature**

Prof. Dr. Mohamed Hafez Fahmi Ali
Professor of Railway Engineering
Faculty of Engineering -Transportation Department - Alexandria University

Prof. Dr. Ali Abd Al Fattah Ali
Professor of Soil mechanics and Foundations Engineering
Faculty of Engineering -Structure Department - Ain Shams University

Prof. Dr. Amr Ali Abd Al Rahman
Professor of Reinforced Concrete Structures
Faculty of Engineering -Structure Department -Ain Shams University

Dr. Hany Sobhy Riad
Associate Professor of Railway Engineering
Faculty of Engineering-Public works Department - Ain Shams University

Cairo, Egypt

2021

TITLE SHEET

Name	: Mohamed Youssef Mohsen Youssef
Degree	: Doctor of Philosophy
Department	: Public Works
Faculty	: Engineering
University	: Ain Shams
Graduation Year	: 2006
Degree Granting Year	: 2021

Author

Name:	***Mohamed Youssef Mohsen Youssef***
Date of birth:	April 28th 1984
Place of birth:	Suez, Egypt
Scientific Degrees:	B.Sc. Civil Engineering – Higher Technological Institute - August 2006
	M.Sc. Civil Engineering – Public Works – Ain Shams University – February 2013
Present position	Assistant Lecturer Faculty of Engineering Beni-Suef University Beni-Suef, Egypt (2013 – present date)

STATEMENT

This thesis is submitted to the public works department, faculty of engineering, Ain Shams University in the partial fulfillment of the requirements for the degree of Doctor of Philosophy in Civil Engineering.

The work in this thesis was carried out in the public works department, faculty of engineering, Ain Shams University from May 2016 to September 2021.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Date:

Signature:

Name: Mohamed Youssef Mohsen Youssef

DEDICATION

This work takes a period from my life; I wish to dedicate it to who suffered to educate, prepare, build capacity and help me to be as I am

To My Beloved Father, who was the main motive for holding this degree "I wish you could be here right now dad"

To My Mother for her Cordial Encouragement, Inspiration and love she Devoted to Me

&

To my Sons, Brothers, father and mother in law for lighting up my way

So, any words can't express what I have to say

Acknowledgements

Praise to ALLAH who guided and aided me to bring – forth to light this work and by whose grace this work has been completed.

Also I would like to give my thanks and appreciation to my supervisor **Dr. Hany Sobhy Riad**, Associate professor of Railway engineering, Faculty of Engineering, Ain Shams University, without his advice through the work and personal consultation I would not have been able to complete this work. I am honored to be one of his students.

I am much obliged to my supervisor **Dr. Amr Abd Al Rahman**, Professor of Reinforced Concrete structures, Faculty of Engineering, Ain Shams University, for helpful suggestion & great supporting.

I would like to express my deepest gratitude to **Dr. Mohamed Hafez Fahmi** professor of Railway engineering, Faculty of Engineering, Alexandria University, for his continuous guidance, expert advice and valuable suggestions that greatly enriched this work.

It is also pleasure to express my sincere thanks to **Dr. Ali Abd Al Fattah Ali, Dr. Hany Ibrahim Ahmed and Dr. Mohamed Maher Tawfik** for their kind help and cooperation.

I'd like to express my gratitude to the staff of the Railway Engineering, Ain Shams University, for their help and support.

Finally, the warmest thanks go to my family for their love, faith, continuous support and prayers through the whole period of work.

Mohamed Youssef Mohsen

Investigation on the manufacturing, installing and maintenance management of prestressed monoblock concrete sleeper in Egypt railway network

Supervised by:

Prof. Dr. Eng. Amr Ali Abd El Rahman

Dr. Hany Sobhy Raid

Dr. Hany Ibrahim Ahmed

Dr. Mohamed Maher Tawfik

Name:	**Mohamed Youssef Mohsen Youssef**
Degree:	**Doctor of Philosophy**
Department:	**Public works**
Faculty:	**Engineering**
University:	**Higher Technological Institute**
Graduation year:	**2006**
Degree granting Year:	**2021**

ABSTRACT

The present research has main objectives to; study precisely the mechanism of loads transfer from rail to sleeper, stresses of monoblock PCS B70 due to vertical loads, determine the suitable spacing for monoblock PCS B70 in Egypt Railway Network (ENR) due to vertical and longitudinal load (excluding longitudinal forces due to thermal effect) together as well as the manufacturing methods and recommending the best one. Also it aims to suggest sleeper's maintenance techniques to avoid track's longitudinal, transverse and horizontal defects

Concerning manufacturing techniques, a field survey to Siegwart factory and a comparison between the carousel (short line) and long-line methods has been carried out.

Two methodologies are proposed to determine the suitable spacing of mono-block prestressed concrete sleeper under vertical load and longitudinal forces:

The first is to determine suitable spacing under vertical loads, a methodology within three steps run through selecting the proper rail and the calculation of the corresponding stresses with respect to speed. Another three steps has been used for PCS design through studying wheel load distribution and applying Zimmerman's formula to calculate sleeper share.

The first methodology showed the suitable sleeper design and spacing with respect to rail type, train speed, sleeper share and the corresponding maximum stress as well as the actual ballast crushing strength. The study also proposed the effective ballast depth with respect to sleeper spacing and share, train speed and rail type.

The second is to determine the suitable spacing due to longitudinal forces (excluding longitudinal forces due to thermal effect) through four sources which are the resulting force from driving wheel, idle wheel rotation, brakes and rotation on inclined plan, where the effect of these forces will be studied for the following three cases; train runs on horizontal straight track, train stops on an inclined track and train brakes on horizontal straight track.

The second methodology determined a different sleeper spacing along the track based on the status of the train either it is accelerating, running with uniform speed or braking.

The research has:

- Concluded that Long-line is more effective & productive than Carousel method
- Suggested some technical rules for PCS maintenance
- Recommended an effective sleeper spacing which fit both vertical loads and longitudinal forces as they occurs simultaneously.
- Carried out a feasibility study to calculate the sleeper saving when applying the new spacing before, after, at and between stations

Summary for the PhD. Degree

Presented by

Mohamed Youssef Mohsen Youssef

"Department of Public works, Ain Shams University"

Title of thesis:

"Investigation on the manufacturing, installing and maintenance management of prestressed monoblock concrete sleeper in Egypt railway network"

Nowadays railway plays a great role in the transportation network. Railway track is composed of rail, fastenings and sleepers (superstructure) rested on ballast and subgrade (substructure). Sleepers are considered as the most important structural elements of railway track, which are transverse beams resting on ballast support as it distributes pressure, transfers load to the beneath layers, maintains the track gauge, provides lateral stability of the track and keeps the geometrical conditions along the track.

Sleepers are exposed to vertical, longitudinal and lateral forces which should be transferred to the ballast layer achieving permissible stress with permanent de-formation and minimum disturbance of the track.

Concrete sleepers are used worldwide as they become a big competitor to timber sleepers. During the Second World War, Prestressed concrete sleepers (PCSs) were developed as it have many advantages such as its heavy weight which gives stability when the axle load is heavy, train speed and traffic are high Furthermore, PCSs are more sustainable than timber sleeper, as It has been reported that the life cycle of PCSs are two to six times of the timber sleepers.

The present research has a main objective to determine precisely the suitable method in manufacturing and maintenance as well as the most effective sleeper spacing along the track and how much feasible will be by applying the new spacing. Two methodologies are proposed to determine the suitable spacing and design of mono-block prestressed concrete sleeper under vertical load and longitudinal forces.

First methodology is composed of two parts:

- Part one: Consists of three steps to determine suitable spacing according to rail type, train speed and sleeper share from the vertical load.
- Part two: Consists of three steps to determine the suitable sleeper design under vertical load according to rail type, train speed, corresponding maximum stress in sleeper and ballast crushing strength.

The study also proposed the effective ballast depth with respect to sleeper spacing and share, as a function of train speed and rail type.

The second methodology:

Studies the effect of longitudinal forces (excluding longitudinal forces due to thermal effect) on sleepers in the following three cases: train runs on horizontal straight track, train stops on an inclined track and train brakes on horizontal straight track which will develop a new sleeper spacing differs from that comes from vertical load.

A final sleeper spacing has been selected to fit the requirement of both vertical loads and longitudinal forces as they takes place simultaneously.

The thesis consists of eight chapters

- Chapter 1: Introduction

This chapter defines the problem definition, thesis hypothesis, scopes, objectives, methodology and contents.

- Chapter 2: Literature review

The study introduces some of research projects, research papers and research thesis for Investigation on the manufacturing, installing and maintenance management of prestressed monoblock concrete sleeper in Egypt railway network.

- Chapter 3: Railway track functions and characteristics

This chapter defines each part of the track and its function starting from subgrade and the ballast section then the sleepers, fastening system and rails as well as the track forces and its effect on the track components.

- Chapter 4: Sleeper types and failure mechanism

This chapter analyzes and compare between different type of sleepers through their advantage and disadvantages whether it was timber, steel, twin block or monoblock concrete sleeper and its failure mechanism

- Chapter 5: Manufacturing, design and maintenance of mono block prestressed concrete sleeper used in ENR (B70 - W14 - 2.4 - 54 - 1/20).

This chapter illustrate the manufacturing steps of the mono block prestressed concrete sleeper at Siegwart factory in 15^{th} of May city starting from sleeper component preparation passing by the following processes; mixing, casting, stressing and storage as well as sleeper design and testing.

- Chapter 6: Modeling of the best design and suitable spacing for PCS due to vertical and longitudinal loads

The methodology in this chapter proposed an optimal design of prestressed monoblock concrete sleeper and calculates the suitable spacing with the appropriate ballast depth under vertical loads as well as the suitable sleeper spacing corresponding to longitudinal forces for

passenger, freight trains and mixed traffic either on horizontal straight or inclined track due acceleration, uniform speed and braking.

- Chapter 7: Data analysis & results

This chapter analyzes the sleeper share from the vertical load, thus a new sleeper spacing and ballast depth developed according to rail type and speed as well as analyzing the suitable sleeper spacing corresponding to longitudinal forces according to train type, grade and running status. Finally a feasibility study was carried out to calculate the following:

- Total cost for single and double track when using different rail types for different speeds
- Sleeper saving when applying the new spacing before, after, at and between stations due to vertical and longitudinal forces together.

- Chapter 8: Conclusion and recommendation

Chapter eight deals with conclusions and recommendations of this study and give some proposed further studies.

References

Keywords:
Egyptian Railway Network, Sleeper Manufacturing, Sleeper Installing, Sleeper Maintenance, Sleeper Renewal, Prestressed Mono-Block concrete sleeper, B70 Sleeper, Sleeper Spacing, Sleeper Design, Effective Ballast Depth, Sleeper Feasibility Study, Dynamic Impact coefficient, sleeper under vertical load and longitudinal force.

Appendix:

Photos from the sleeper manufacturing process – samples of crack types in concrete sleepers in ENR – Calculations from the proposed methodology for sleepers best design and ballast depth – Calculations from the proposed methodology for the suitable sleeper spacing – letter from Book Publisher International (http://www.bookpi.org) informing that the paper under title “Optimal Design and Spacing of Mono-Block Prestressed Concrete Sleeper under Vertical load” has been selected to be one of the following book chapter’s “Emerging Trends in Engineering Research and Technology”.