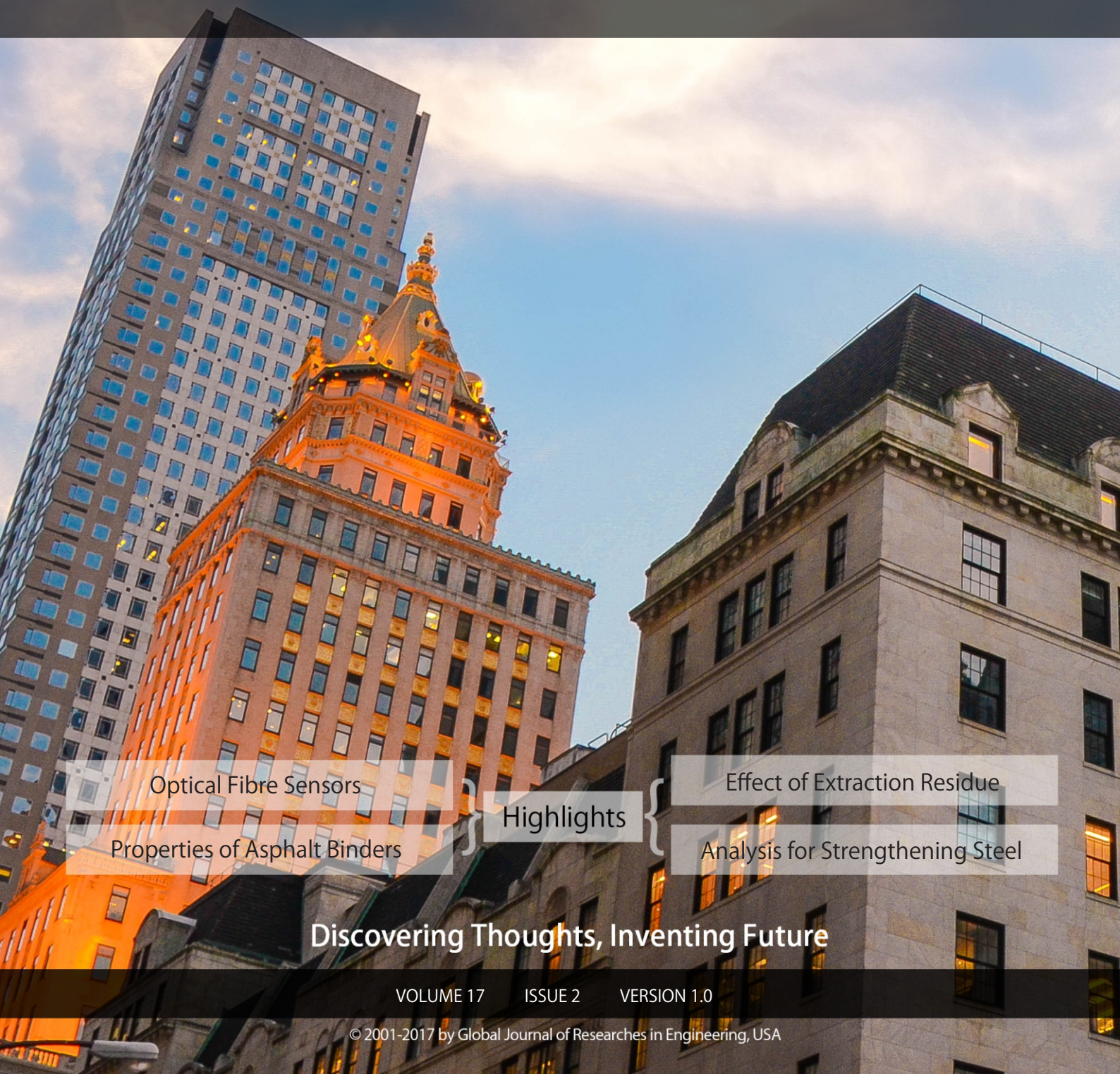
Online ISSN : 2249-4596
Print ISSN : 0975-5861
DOI : 10.17406/GJRE

Global Journal

of Researches in Engineering: E

Civil and Structural Engineering



Optical Fibre Sensors

Properties of Asphalt Binders

Highlights

Effect of Extraction Residue

Analysis for Strengthening Steel

Discovering Thoughts, Inventing Future

VOLUME 17 ISSUE 2 VERSION 1.0

Global Journal of Researches in Engineering: E
Civil And Structural Engineering

Global Journal of Researches in Engineering: E
Civil And Structural Engineering
Volume 17 Issue 2 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals Pvt. Ltd.
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Editorial Board

Global Journal of Research in Engineering

Dr. Joaquim Carneiro

Ph.D. in Mechanical Engineering,
Faculty of Engineering,
University of Porto(FEUP),
University of Minho,
Department of Physics, Portugal

Dr. Hai-Wen Li

Ph.D., Materials Engineering
Kyushu University
Fukuoka
Guest Professor at Aarhus University, Japan

Dr. Wei-Hsin Chen

Ph.D., National Cheng Kung University
Department of Aeronautics
and Astronautics, Taiwan

Dr. Saeed Chehreh Chelgani

Ph.D. in Mineral Processing
University of Western Ontario,
Adjunct professor,
Mining engineering and Mineral processing
University of Michigan

Belen Riveiro

Ph.D.,
School of Industrial Engineering
University of Vigo, Spain

Dr. Bin Chen

B.Sc., M.Sc., Ph.D., Xi'an Jiaotong University, China.
State Key Laboratory of Multiphase Flow in Power Engineering
Xi'an Jiaotong University, China

Dr. Maurizio Palesi

Ph.D. in Computer Engineering,
University of Catania
Faculty of Engineering and Architecture
Italy

Dr. Cesar M. A. Vasques

Ph.D., Mechanical Engineering
Department of Mechanical Engineering
School of Engineering, Polytechnic of Porto
Porto, Portugal

Dr. Stefano Invernizzi

Ph.D. in Structural Engineering
Technical University of Turin,
Department of Structural,
Geotechnical and Building Engineering, Italy

Dr. T.S. Jang

Ph.D. Naval Architecture and Ocean Engineering
Seoul National University, Korea
Director, Arctic Engineering Research Center,
The Korea Ship and Offshore Research Institute,
Pusan National University, South Korea

Dr. Jun Wang

Ph.D. in Architecture, University of Hong Kong, China
Urban Studies
City University of Hong Kong, China

Dr. Salvatore Brischetto

Ph.D. in Aerospace Engineering, Polytechnic University of Turin and
in Mechanics, Paris West University Nanterre La Défense
Department of Mechanical and Aerospace Engineering,
Polytechnic University of Turin, Italy

Dr. Francesco Tornabene

Ph.D. in Structural Mechanics, University of Bologna
Professor Department of Civil, Chemical, Environmental and Materials Engineering
University of Bologna, Italy

Dr. Wesam S. Alaloul

B.Sc., M.Sc.,
Ph.D. in Civil and Environmental Engineering,
University Technology Petronas, Malaysia

Dr. Togay Ozbakkaloglu

B.Sc. in Civil Engineering
Ph.D. in Structural Engineering, University of Ottawa, Canada
Senior Lecturer University of Adelaide, Australia

Dr. Sofoklis S. Makridis

B.Sc(Hons), M.Eng, Ph.D.
Professor Department of Mechanical Engineering
University of Western Macedonia, Greece

Dr. Paolo Veronesi

Ph.D., Materials Engineering
Institute of Electronics, Italy
President of the master Degree in Materials Engineering
Dept. of Engineering, Italy

Dr. Ananda Kumar Palaniappan

B.Sc., MBA, MED, Ph.D. in Civil and Environmental Engineering,
Ph.D. University of Malaya, Malaysia
University of Malaya, Malaysia

Dr. Maria Daniela

Ph.D. in Aerospace Science and Technologies
Second University of Naples
Research Fellow University of Naples "Federico II", Italy

Dr. Zhen Yuan

B.E., Ph.D. in Mechanical Engineering
University of Sciences and Technology of China, China
Professor, Faculty of Health Sciences, University of Macau, China

Dr. Charles-Darwin Annan

Ph.D.,
Professor Civil and Water Engineering University Laval, Canada

Dr. Hugo Silva

Associate Professor
University of Minho
Department of Civil Engineering
Ph.D., Civil Engineering
University of Minho, Portugal

Dr. Stefano Mariani

Associate Professor
Structural Mechanics
Department of Civil
and Environmental Engineering,
Ph.D., in Structural Engineering
Polytechnic University of Milan, Italy

Dr. Jui-Sheng Chou

Ph.D. University of Texas at Austin, U.S.A.
Department of Civil and Construction Engineering
National Taiwan University of Science and Technology (Taiwan Tech)

Dr. Shaoping Xiao

BS, MS
Ph.D. Mechanical Engineering, Northwestern University
The University of Iowa
Department of Mechanical and Industrial Engineering
Center for Computer-Aided Design

Dr. Vladimir Gurao

Associate Professor
Ph.D. in Mechanical /
Aerospace Engineering
University of Miami
Engineering Technology

Dr. Adel Al Jumaily

Ph.D. Electrical Engineering (AI)
Faculty of Engineering and IT
University of Technology, Sydney

Dr. A. Stegou-Sagia

Ph.D. Mechanical Engineering, Environmental
Engineering School of Mechanical Engineering
National Technical University of Athens

Dr. Jalal Kafashan

Mechanical Engineering
Division of Mechatronics
KU Leuven, BELGIUM

Dr. Fausto Gallucci

Associate Professor
Chemical Process Intensification (SPI)
Faculty of Chemical
Engineering and Chemistry
Assistant Editor
International J. Hydrogen Energy, Netherlands

Prof. (LU) Prof. (UoS) Dr. Miklas Scholz

Cand Ing, BEng (equiv), PgC, MSc, Ph.D., CWEM, CEnv, CSci, CEng,
FHEA, FIEMA, FCIWEM, FICE, Fellow of IWA,
VINNOVA Fellow, Marie Curie Senior Fellow,
Chair in Civil Engineering (UoS)
Wetland systems, sustainable drainage, and water quality

Dr. Houfa Shen

Ph.D. Manufacturing Engineering, Mechanical Engineering, Structural Engineering
Department of Mechanical Engineering
Tsinghua University, China

Dr. Kitipong Jaojaruek

B. Eng, M. Eng
D. Eng (Energy Technology, Asian Institute of Technology).
Kasetsart University Kamphaeng Saen (KPS) Campus
Energy Research Laboratory of Mechanical Engineering

Dr. Haijian Shi

Ph.D. Civil Engineering
Structural Engineering
Oakland, CA, United States

Dr. Zhibin Lin

Center for Infrastructure Engineering Studies
Missouri University of Science and Technology
ERL, 500 W. 16th St. Rolla,
Missouri 65409, US

Dr. Chao Wang

Ph.D. in Computational Mechanics
Rosharon, TX,
US

Dr. Shun-Chung Lee

Department of Resources Engineering,
National Cheng Kung University, Taiwan

Hiroshi Sekimoto

Professor Emeritus
Tokyo Institute of Technology, Japan
Ph.D., University of California, Berkeley

Dr. Philip T Moore

Ph.D., Graduate
Master Supervisor
School of Information
Science and engineering
Lanzhou University, China

Dr. Steffen Lehmann

Faculty of Creative and
Cultural Industries
PhD, AA Dip
University of Portsmouth, UK

Dr. Gordana Colovic

B.Sc Textile Technology, M.Sc. Technical Science
Ph.D. in Industrial management.
The College of Textile – Design, Technology and Management, Belgrade, Serbia

Dr. Yudong Zhang

B.S., M.S., Ph.D. Signal and Information Processing,
Southeast University
Professor School of Information Science and Technology at Nanjing Normal University, China

Dr. Xianbo Zhao

Ph.D. Department of Building,
National University of Singapore, Singapore,
Senior Lecturer, Central Queensland University, Australia

Dr. Philip G. Moscoso

Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich
Link: Philip G. Moscoso personal webpage

Contents of the Issue

Global Journal of Researches in Engineering: E
Civil And Structural Engineering
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Numerical Analysis for Strengthening Steel Trusses using Post Tensioned Cables

By Mohamed Ghannam, Nabil S. Mahmoud, Ahmed Badr & Fikry A. Salem
Mansoura University

Abstract- Using post tensioned cables becomes one of the most effective methods in strengthening different types of structures especially steel structure. This paper studies the effect of post tensioned cables in strengthening double span steel trusses. Different truss's systems (Warren and N truss system) are included in this study.

Different techniques using post tensioned cables are used in strengthening different truss's systems. The main difference between these techniques is the profile and the locations of the post tensioned cables. Comparisons between these techniques are made in order to determine the suitable post tensioning technique for each truss system. The analysis and results are obtained by using ANSYS program.

Keywords: post tensioned, cables, strengthening, steel trusses, ANSYS.

GJRE-E Classification: FOR Code: 090699

Strictly as per the compliance and regulations of :

Numerical Analysis for Strengthening Steel Trusses using Post Tensioned Cables

Mohamed Ghannam [α], Nabil S. Mahmoud [σ], Ahmed Badr [ρ] & Fikry A. Salem [ω]

Abstract- Using post tensioned cables becomes one of the most effective methods in strengthening different types of structures especially steel structure. This paper studies the effect of post tensioned cables in strengthening double span steel trusses. Different truss's systems (Warren and N truss system) are included in this study.

Different techniques using post tensioned cables are used in strengthening different truss's systems. The main difference between these techniques is the profile and the locations of the post tensioned cables. Comparisons between these techniques are made in order to determine the suitable post tensioning technique for each truss system. The analysis and results are obtained by using ANSYS program.

Keywords: post tensioned, cables, strengthening, steel trusses, ANSYS.

I. Introduction

Post tensioning is one of the most effective methods for strengthening an existing structure to overcome the increase in service load without replacement parts of the structure. The aim of this paper is to study the effect of post tensioning in strengthening different types of steel trusses and find a suitable way to apply post tensioning in each type. Many researchers studied the effect of post tensioning on strengthening different types of structures.

Previously, researchers study the effect of post tensioning on strengthening steel beams, especially those used in bridges. Dunker et al. [1] presented a research which studied the strengthening of existing single-span steel-beam with concrete deck bridges. Klaiber et al. [2] studied the effect of post tensioning on strengthening an existing continuous-span steel-beam with concrete deck bridge. It was concluded that post tensioning is a viable, economical strengthening technique. Ayyub et al. [3] studied the pre-stressing of a composite girder subjected to a positive moment. It was concluded that using strands is preferable than using bars in post-tensioning. Ayyub et al. [4, 5] presented an experimental and analytical study for prestressing composite girder subjected to negative moment. The research shows that using post tensioning decreases the crack in the negative moment region and reduces the required steel material. Phares et al. [6] presented a research on strengthening of steel girder bridges using post tensioned rods of carbon fibre reinforced polymers (CFRP). The research showed the significant effect of using post tensioned CFRP in increasing the load capacity of the bridge. Nazir [7] showed that using post tensioned cable for a pre-stressed arch steel bridge has a great effect in reducing the stress on the arch girder.

As the effect of post tensioning cables in strengthening different types of structure becomes obvious, many researchers [8-11] used post tensioning cables in earthquake-resistant in structural steel moment resisting frame (MRF) system, which is known as self-centering moment-resisting frame (SC-MRF) structural system. This type of connection uses high strength post tensioned cables to pre-compress the beams to the columns and to close the gaps that were developed under earthquake loading, returning the frame to its initial position [12]. Vasdravellis et al. [13] proposed a new self-centering beam-to-column connection. The connection used post tensioned high strength steel bars to provide self-centering capability and designed energy-dissipation (ED) elements that consisted of steel cylindrical pins with an hourglass shape. Mahmoud et al. [14] studied the effect of using eccentric post tensioned cables in strengthening simple frame. Different post tensioning techniques were proposed for strengthening simple steel frames. The result shows that using post tensioning cables in strengthening simple steel frames can increase the load capacity by more than 30 %. Similar result where reported by the research done by Ghannam et al. [15].

Ghannam et al. [16] showed that post tensioned cables can increase the load capacity of box girder steel bridge by 25% with a factor of safety equal to 1.8 and 3.63 according to AASHTO LRFD (17) and ECP No. 201 (18) loading vehicles respectively.

Steel trusses are one of the most important types of structures in our life. Nowadays, steel trusses are used in workshops, factory building, stadiums roof, bus and train stations and bridges. Due to the increase in service load applied to steel trusses, researchers began to study different methods to strengthen steel trusses. Using post tensioned cables in strengthening different types of steel trusses are one of the most efficient and widely acceptable methods.

Ayyub et al. [19] and Ayyub and Ibrahim [20] studied the effect of using post tensioned cables on strengthening steel trusses bridge. Single span bridges with different trusses system were investigated in this

Author α σ ρ ω: Structural Engineering Department, Faculty of Engineering, Mansoura University, Mansoura, Egypt.
e-mail: m.ghannam@mans.edu.eg

study. Also the effect of different tendon layout was studied. It was concluded that post tensioning tendon is a cost-effective method to strengthen steel trusses and can increase the redundancy levels as well as the reliability of the truss structures to meet the increase in service loading requirements. Post tensioning also enlarges the elastic range, increases the fatigue resistance and reduces deflection and member's stress. Thus, the remaining life of a truss bridge can be extended. More details will be given about this study in section 2.1 of this paper.

Han and Park [21] studied the elastic behaviour of post tensioned steel trusses with straight and draped tendon profiles. The effect of different parameters on the working load and the deflection of truss were studied. These parameters were: tendon profile, truss type, pre-stressing force and tendon eccentricity. Similar to Ayyub et al. [19] and Ayyub and Ibrahim [20], it was concluded that post tensioning enlarges the elastic range, increases the redundancy and reduces the deflection and member's stress. As a result, the load carrying capacity of the truss was increased. Nowadays, there are lots of applications of post tensioned steel trusses for long span roofs especially in stadiums such as Telstra Stadium in Australia [22].

From the literature, it can be concluded that using post tensioned cables is one of the most effective methods in strengthening different types of buildings and structures. Also it was observed from the literature that the effect of post tensioned cables was not investigated on continuous span steel trusses. This paper studies the effect of post tensioned cables in strengthening double span steel trusses. Warren and N truss system are included in this study. Different post tensioning techniques are investigated to check the ability of these methods in strengthening different types of trusses. The main difference between these techniques is the layout and the profile of the post tensioned cables.

II. Finite Element Analysis

a) Ayyub et al truss model

The main objective of this paper it to study the effect of different post tensioned cables profile on strengthening double span steel trusses. The numerical study is performed using ANSYS Finite element (FE) program [23]. It is very important to verify the FE model before proceeding to the main objective of this paper. The FE model is verified against the result obtained by Ayyub et al. [19].

Ayyub et al. [19] studied the effect of using post tensioned cables on strengthening steel trusses bridge. Single span bridges with different trusses system were investigated in this study. Also the effect of different tendon layout was studied. In this study, the analysis of post-tensioned trusses is divided into three steps. In the first step, an analysis is performed using the dead load. In the second step, the analysis is performed using the dead and the posttensioning loads as applied to the truss joints. In last step, an analysis is performed using the live loads including impacts. The stiffness of the tendons is considered only in the third analysis stage. The final solution is achieved by superimposing the second and third step.

In this study three examples were presented. The first example was a statically determinate truss post tensioned internally; the second example was indeterminate truss post tensioned internally and the last example was statically determinate trusses post tensioned externally. It was decided to use the statically determinate trusses that were post tensioned internally and externally for the verification of the FE model. The discretion of the statically determinate trusses is indicated in the following paragraphs.

The detail of the truss that was used in the analysis is described as follows. The truss was a warren single span truss with a height of 11582.4 mm and consists of 8 panels of 8229.6 mm length each. The truss is loaded at 3 point as indicated in Figure 1 the value for dead load was 450 kN and the value for live load and impact was 900 kN, forming a total load of 135o kN as indicated in Figure 1.

Four different cables layout were used to apply post tensioning to the truss. Here, each layout will be referred as a technique. In the 1st technique, a straight cable was used, this cable was coinciding with the lower member joining between the two supports of the truss, and this layout is indicated in Figure 2.

In the 2nd technique, one drape cable was used; this cable was joining between node U0 and U8 passing through node L4 as shown in Figure 3. In the 3rd technique, two drape post tensioned cable was used, this cable begins at node U1 passing through node L2, L6 and ending at node U7 as shown in Figure 4.

In the 4th technique, the cable was post tensioned externally as indicated in Figure 5. Two drape post tensioned cable are anchored at nodes L0 and L8 and pass over two pulleys at nodes D1 and D2. Two vertical members (L1,D1) and (L2, D2), two diagonal members (D1, L2)and(D7, L6) are added to achieve the stability of the truss as shown in Figure 5. The distance between the post tensioned cable and the lower member of the truss was 6319.5 mm.

In the first three techniques, the cables consist of three strands of 15.24 mm diameter and an ultimate tensile strength of 1860 MPa. The cross sectional area of the cables was 548 mm^2. The cables were post tensioned by a force equal to 927 kN giving a post tensioning stress equal to 1674 MPa. This stress corresponds to 85% of the ultimate strength of the strands as indicated by Ayyub et al. [19].

In the 4th technique, the cables consist of two strands of 15.24mm diameter and an ultimate tensile

strength of 1722.5 MPa. The cross sectional area of the cables was 361mm^2. The cables were post tensioned by a force equal to 45 kN giving a tensioning stress equal to 1266.4 MPa. This stress corresponds to 70% of the ultimate strength of the strands strands as indicated by Ayyub et al. [19].

b) Finite element model description

Link element (8) is used to model the truss member, beam element (4) is used to model the post tensioned cable. It should be noted that the beam element is used with axial stiffness only with ignoring the bending stiffness. Beam element (4) is used to model the cable to overcome the convergence problem that may occur when using Link element (8) to model the post tensioned cable. Post tensioned load is applied by using Pretension element (179), this element splits the cable in to two part and apply the tension force in each part, and this is the reason of using beam element (4) to model the cable.

The poly that is used in the 3rd and the 4th technique is indicated in Figure 6 (a and b) respectively. In the 3rd technique, a connecting link member is added to connect between the truss joint and the post tensioned cable. It should be noted that the axial stiffness of this added link is very small so that it will not affect on the load distribution in the truss member, also its length is very short. This connecting link is added so that the angle between the drape cable is divided equally. A rotational restrained is assigned to joint connecting the cable to the connecting link.

In the 4th technique, another method was used to model the poly. The same connecting link that is used in the 3rd technique is used here with the same properties and dimensions. However, instead of adding a rational restrains, an additional cable is added at the joint connecting between the cable and the connecting link as indicated in Figure 6 (b), the addition link has also a very small axial stiffness and length. A rotational and transitional restrains are assigned at the end of the additional link.

c) Verification of finite element model

Table 1 Shows the comparison between the result introduced in Ayyub et al. [19] and the result obtained in from the finite element (FE) model of this study. In this table result of selected truss members is presented, each truss member is identified by its number as indicated in Figure 1, The result presented by the FE model of this study is indicated by FE.

The comparison was done according to two loading cases, the first loading case include the primary loads without post tensioned force, this case includes deal load and live load plus impact. This case is indicated by *N*. The other case includes the primary load plus the post tensioned load which is indicate as *N+P*. It should be noted that the cable load in the 4th technique was not presented in Ayyub et al. [19].

From the comparison of the result through different techniques, it can be concluded that there is good agreement between the result presented by Ayyub et al. [19] and the result presented in this study.

III. Strengthening of Continuous Trusses

a) Warren truss

This section studies the effect of post tensioning on double span warren truss. The dimensions of the warren truss are the same as that were used before in verification the model, the truss height is 11582.4 mm. The truss consists of 8 panels, each panel has a length of 8229.6 mm. The analysis is carried under the effect of dead and live load with impact. The total value of each concentrated load is 1350 kN as indicated in Figure 7. Figure 7 shows the numbering system of the truss members in one span. Seven post tensioning techniques are used to strengthen the truss. These seven techniques are described in details in the following sub sections.

i. *Technique of the Warren Truss*

In this technique, the post tensioned cable is coincide with the lower tensioned member as indicated in Figure 8. The cables consists of three strands of 15.24mm diameter and an ultimate tensile strength of 1860MPa. The cross sectional area of the cables is 548mm^2. The cables initially post tensioned by a force equal to 925 kN.

ii. *Technique of the Warren Truss*

In this technique, the post tensioned cable is coincide with the upper tensioned member as indicated in Figure 9. The cross section of the cables and the post tensioning force are the same as the 1st technique.

iii. *Technique of the warren truss*

In this technique, two external draped post tensioned cables are used parallel to the lower chord members. The distance between the cables and the lower truss member is 3159.8 mm. Another post tensioned cable is used coincide with the two upper central chord member as indicated in Figure 10. The post tensioned force for the external draped cable is 143 kN and for the straight cable is 770 kN.

iv. *Technique of the warren truss*

In this technique, straight cable is used coincide with the lower chord members and external straight cable is used parallel to the two upper central chord members as shown in Figure 11. The post tensioned force for the lower straight cable is 201 kN and 770 kN for the upper cable.

v. *Technique of the warren truss*

Straight cable is used coincide with the lower chord members and a straight cable is used coincide with the two upper central chord members as show in

Figure 12. The post tensioned force for the cable is 183 kN and 770 kN for the upper cable.

vi. *Technique of the warren truss*

Two external draped cables are used parallel to the lower chord members and external straight cable is used parallel to the two upper central chord members as shown in Figure 13. The post tensioned force is 156 kN for the lower cable and 770 kN for the upper cable.

vii. *Technique of the warren truss*

In this technique, two draped cables post tensioned by 770 kN are used in each span as indicated in Figure 14.

b) N truss

This section studies the effect of post tensioning on double span warren truss. The dimensions of the N truss are the same as that were used before in verification the model, the truss height is 11582.4 mm. The truss consists of 8 panels, each panel has a length of 8229.6 mm. The analysis is carried under the effect of dead and live load with impact. The total value of each concentrated load is 1350 kN as indicated in Figure 15. Figure 15 shows the numbering system of the truss members in one span. Seven post tensioning techniques are used to strengthen the truss. These seven techniques are described in details in the following sub sections.

i. *Technique of the N truss*

In this technique, the post tensioned cable is used coincide with the lower tensioned member as indicated in Figure 16.

ii. *Technique of the N truss*

In this technique, the post tensioned cable is coincide with the upper tensioned member as indicated in Figure 17.

iii. *Technique of the N truss*

In this technique, two external draped post tensioned cables are used parallel to the lower chord members, The distance between the cables and the lower truss member is 3159.8 mm. Another post tensioned cable is used coincide with the two upper central chord member as indicated in Figure 18. The post tensioned force for the external draped cable is 143 kN and for the straight cable is 770 kN.

iv. *Technique of the N truss*

In this technique, straight cable is used coincide with the lower chord members and external straight cable is used parallel to the two upper central chord members as shown in Figure 19, the distance between the cable and the upper member is 3159.8 mm. The post tensioning force for the lower straight cable is 275 kN and for the upper cable is 770 kN.

v. *Technique of the N truss*

Straight cable is used coincide with the lower chord members and a straight cable is used coincide with the two upper central chord members as show in Figure 20. The post tensioned force for the cable is 169 kN and 770 kN for the upper cable

vi. *Technique of the N truss*

Two external draped cables are used parallel to the lower chord members and external straight cable is used parallel to the two upper central chord members as shown in Figure 21. The post tensioned force is 222 kN for the lower cable and 770 kN for the upper cable

vii. *Technique of the N truss*

In this technique, two draped cables post tensioned by 770 kN are used in each span as indicated in Figure 22.

IV. Results and Discussions

From the previous sections, it can be noticed that in different techniques, the post tensioning force which was applied to the post tensioned cables that were located close to upper chord members was chosen to be 770 kN. This value was chosen in order to eliminate the internal tension force of the two middle upper chord members. The post tensioning force of the cables that are located close to the lower chord member was chosen with different values for different techniques. The value of the post tensioning force of the lower cables was chosen based on which value will give the most reduction of the internal forces of the truss members with keeping the post tensioned force in the upper cable constant as 770 kN.

Table 2 shows the percentage of reductions in the truss members' internal tension and compression forces after using different post tensioning techniques with continuous Warren and N trusses. It should be noted that in Table 2 that, % *Ten.* refer to the total reduction in the internal forces of all tension members, % *Comp.* refer to the total reduction in the internal forces of all compression members. In Table 2, +ve numbers mean a reduction in the truss members' internal force and -ve numbers mean an increase in the truss members' internal force.

It can be concluded from the results obtained in Table 2, that the best technique for strengthening the N truss system, is the 6th techniques, which gives a reduction of 9.84 % of the total internal forces of the tension member and a reduction of 3.19 % of the total internal compression forces. Although the 7th techniques provides a reduction of 21.77 % of the total internal tension forces, however, this techniques cause an increase in the total internal forces of the compression member by 1.42 %.

Also, it can be concluded from the results obtained in Table 2, that the best techniques for strengthening the Warren truss system, are the 3rd and the 5th techniques. 3rd technique gives a reduction of 9.72 % of the total internal forces of the tension member and a reduction of 0.94 % of the total internal

compression forces. 5th technique gives a reduction of 9.91% and 0.016 % for the total tension and compression force respectively. Although the 7th techniques provides a reduction of 21.63 % of the total internal tension forces, however, this techniques cause an increase in the total internal forces of the compression member by 12.9 %.

V. Conclusions

This paper studies the effect of post tensioned cables in strengthening double span steel trusses. Different truss systems (Warren and N truss system) are included in this study. Different techniques using post tensioned cables are used in strengthening different truss systems. The main difference between these techniques is the profile and the locations of the post tensioned cables. Comparisons between these techniques are made in order to determine the suitable post tensioning technique for each truss system. The analysis and results are obtained by using ANSYS program.

From this study, it can be concluded that post tensioning is an effective method in strengthening different types of steel trusses. Strengthening trusses using post tensioned cables can reduce the internal force in both tension and compression members. However, the reductions of the internal tension forces is more significant than the compression forces.

Each type of truss has a specific post tensioned technique that provides the most percentage of reduction in the trusses internal forces. Generally, post tensioning the cable externally has a significant effect in reducing the internal forces, however, care should be taken when using this technique, as it reduces the clearance under the truss. This may have a negative influence on the using purpose of the truss especially, if this truss was designed as a bridge over a water stream where there is a navigation to pass under the truss bridge.

References Références Referencias

1. Dunker K. F., Klaiber F. W., Beck B. L. and Sanders W.W. Strengthening of existing single-span steel-beam and concrete deck bridges. Final Report Part II. ISU- HR-238, ERI Project 1536, ERIAmes-85231: Engineering Research Institute, Iowa State University, Iowa Department of Transportation Highway Division and the Iowa Highway Research Board. 1985.
2. Klaiber F. W., Dunker K. F., Planck S. M. and Sanders W.W. Strengthening of an existing continuous-span, steel-beam, concrete deck bridge by Post-.Tensioning. Final Report, ISU-ERI-Ames - 90210. Ames: Engineering Research Institute, Iowa State University, Iowa Department of Transportation Highway Division and the Iowa Highway Research Board. 1990.
3. Ayyub, B.M., Sohn Y.G and Saadatmanesh, H. Prestressed composite girder under positive moment. journal of structural Engineering. 1990, 116(11); 2931–2951
4. Ayyub B.M., Sohn, Y.G. and saadatmanesh, H. Prestressed composite girder I: experimental study for negative. journal of structural engineering. 1992, 118(10); 2743-2762.
5. Ayyub, B.M., Sohn, Y.G., and Saadatmanesh, H. Prestressed composite Girder II : Analytical study for negative moment. journal of structural engineering. 1992, 118(10), pp 2763–2782.
6. Phares, B.M., Wipf, T.J., Klaiber, F. W., Abu-Hawash, A. and Lee, Y. Strengthening of steel girder bridges using FRP". Proceedings of the 2003 Mid-Continent Transportation Research Symposium, Ames, Iowa. 2003, pp 1-12.
7. Nazir, C.P. Prestressed steel arch bridge, IE (I) Journal .CV. 2003, 84; 72-76.
8. Petty, G.D. Evaluation of a friction component for a post-tensioned steel connection. Theses and Dissertations, Lehigh University. 1999, Paper 629.
9. Ricles, J.M., Sause, R., Wolski, M., Seo, C-Y. , and Iyama J. Post-tensioned moment connections with a bottom flange friction device for seismic resistant selfcentering steel MRFS, 4th International Conference on Earthquake Engineering Taipei, Taiwan October 12-13, 2006, Paper No. 108.
10. Wang, D. and Filiatrault, A. Numerical and experimental studies of self-centering post-tensioned steel frames, Technical Report MCEER-08-0017, University at Buffalo, State University of New York. 2008.
11. Rojas, C.P., Caballero, V.M., Ricles, J.M., and Sause, R. Plastic limit analysis of self-centering steel moment resisting frames with post-tensioned friction damped connections, The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.
12. Lin, Y-C, Sause, R., and Ricles, J.M. Seismic performanceof steel self-centering, moment-resisting frame: hybrid simulations under design basis earthquake. Journal of Structural Engineering, 2013, 139(11); 1823–1832.
13. Vasdravellis, G., Karavasilis, T.L., and Uy, B. Large-scale experimental validation of steel posttensioned connections with web hourglass pins. Journal of structural engineering. 2013, 139(6); 1033–1042.
14. Mahmoud, N.S, Badr A., Ssalem F.A. and Ghannam M. Strengthing Steel Frames by Using Post Tensioned Cable. Life Science Journal. 2014, 11(1); 111-116.
15. Ghannam, M., Mahmoud, N.S, Badr A. and Salem F.A. Effect of post tensioning on strengthening different types of steel frames. Journal of King Saud

University – Engineering Sciences. 2016, Article in press.
16. Ghannam, M., Mahmoud, N.S, Badr A. and Salem F.A. Strengthening and repairing of an existing steel bridge using post tensioning. International journal of civil and structural engineering. 2014, 5(2); 91-100.
17. AASHTO LRFD Bridge Design Specifications The American Associates of State High Way and Transportation Officials, Washington, DC. fourth Edition, 2007.
18. Egyptian Code for Calculating Loads and Forces on Structures, code no. ECP 201. Ministry of Housing, Utilities and Urban Communities, Housing and Building National Research Centre, Cairo, Egypt. 2008.
19. Ayyub B.M., Ibrahim A., Schelling D. Posttensioned trusses: analysis and design. Journal of structural engineering. 2008,116(6); 1491-1506.
20. Ayyub, B.M., and Ibrahim, A. Posttensioned trusses: reliability and redundancy. Journal of structural engineering. 1990, 116, (6); 1507-1521.
21. Han, K-B., and Park S-K. Parametric study of truss bridges by the post-tensioning method, Canadian Journal of Civil Engineering. 2005, 32(2); 420-429.
22. Manley K. Innovation Case Study No 9: Post-tensioned steel trusses for long span roofs, A series of innovation case studies, the BRITE Project of the Cooperative Research Centre for Construction Innovation. 2006, pages 8.
23. ANSYS. Verification Manual, Release 10.0. ANSYS, Inc., 275 Technology Drive, Canonsburg, PA 15317, United States. 2005.

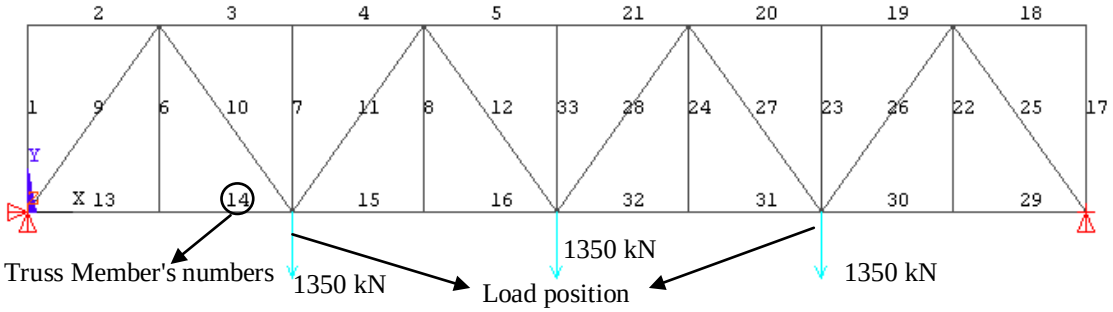


Figure 1: Main truss layout

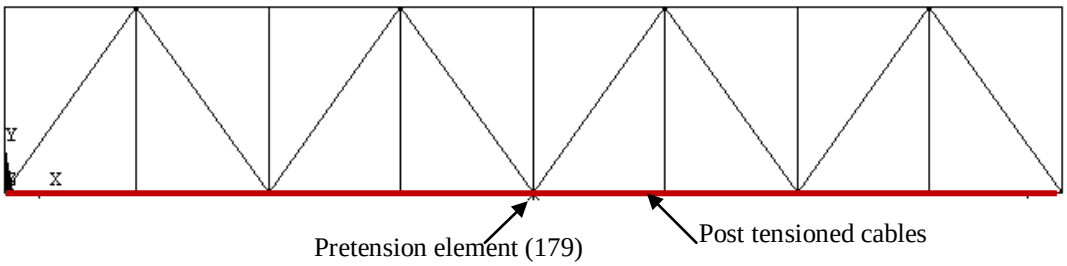


Figure 2: Layout of the 1st technique

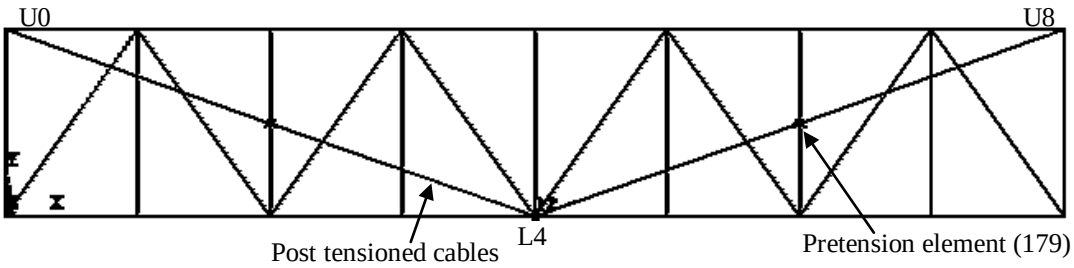


Figure 3: Layout of the 2nd technique

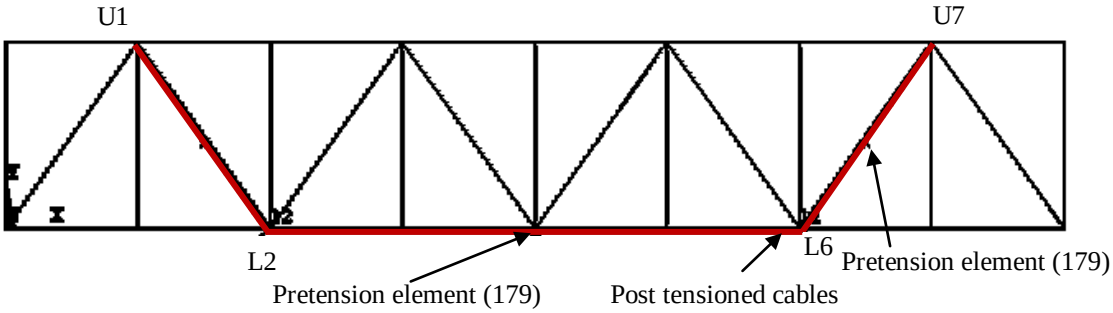


Figure 4: Layout of the 3rd technique

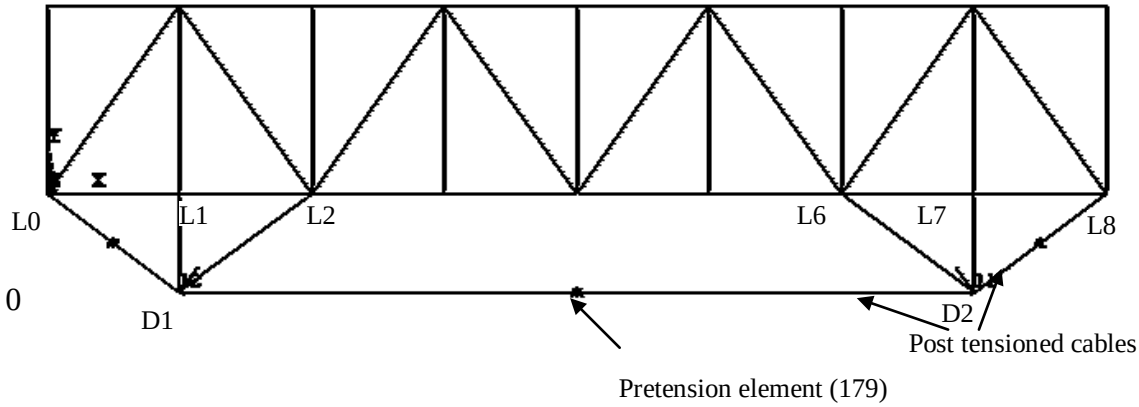
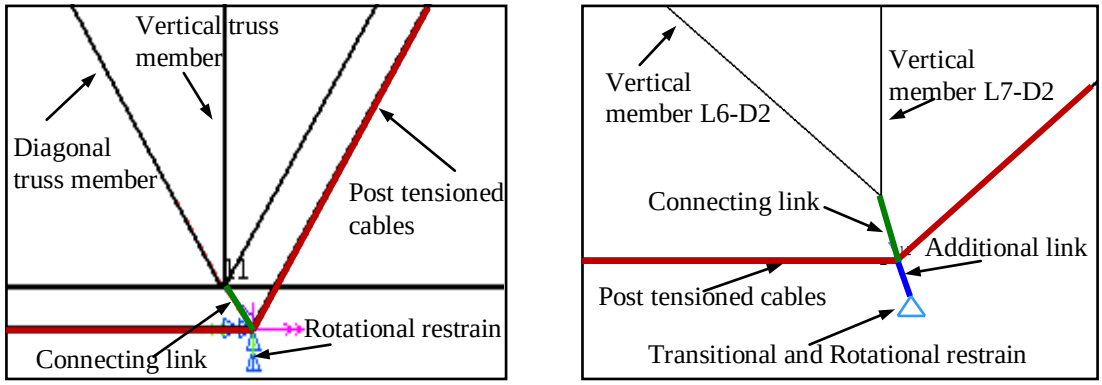


Figure 5: Layout of the 4th technique



(a) 3rd technique (b) 4th technique

Figure 6: Modelling of the poly

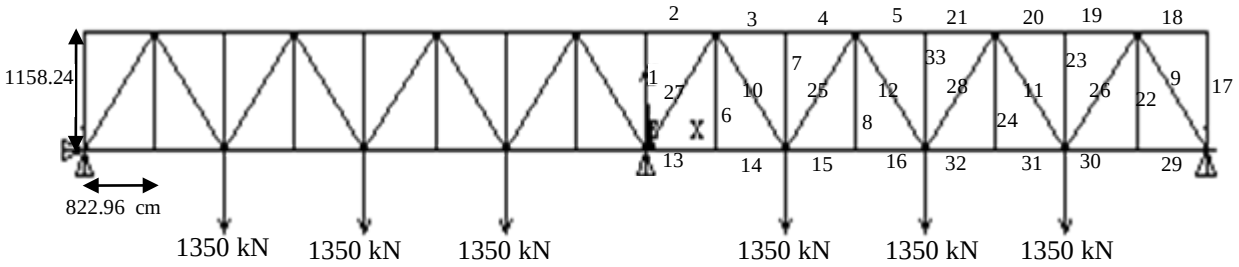


Figure 7: Layout of Warren continuous truss.

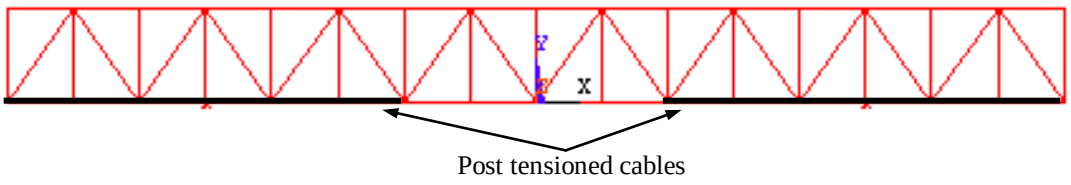


Figure 8: Layout of the 1st technique used for strengthening of the continuous Warren truss

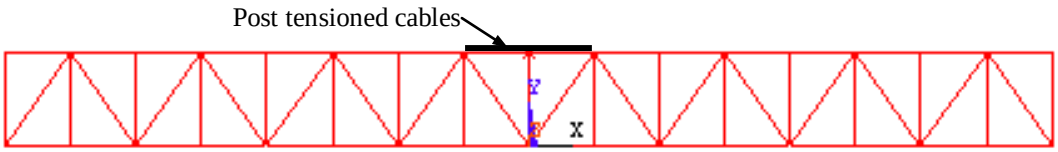


Figure 9: Layout of the 2nd technique used for strengthening of the continuous Warren truss

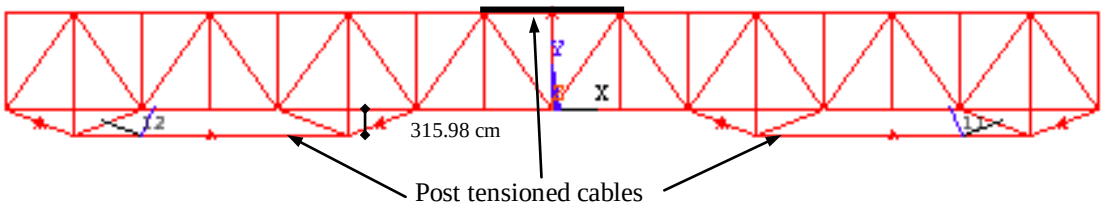


Figure 10: Layout of the 3rd technique used for strengthening of the continuous Warren truss

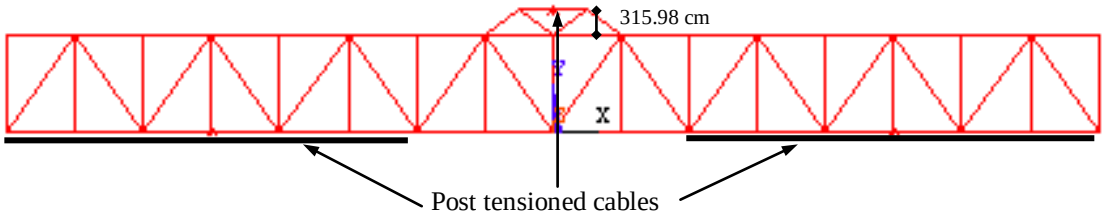


Figure 11: Layout of the 4th technique used for strengthening of the continuous Warren truss

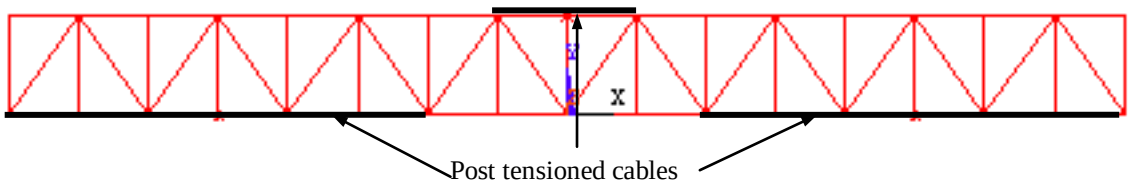


Figure 12: Layout of the 5th technique used for strengthening of the continuous Warren truss

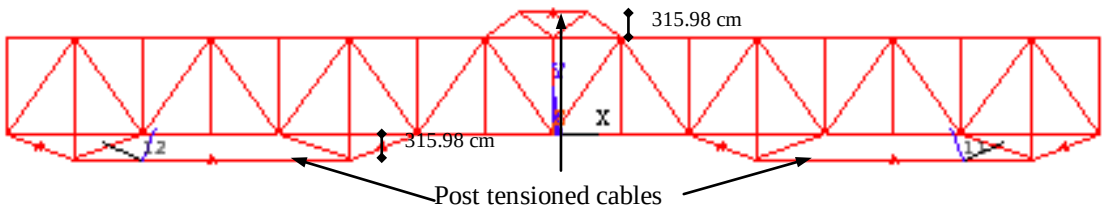


Figure 13: Layout of the 6th technique used for strengthening of the continuous Warren truss

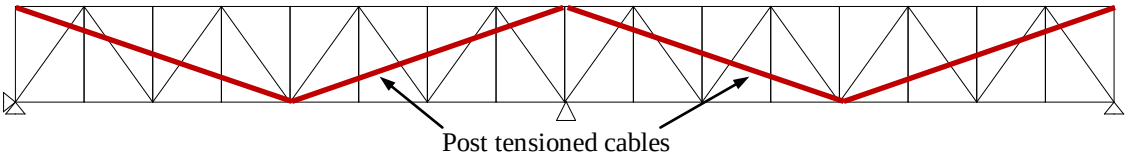


Figure 14: Layout of the 6th technique used for strengthening of the continuous Warren truss

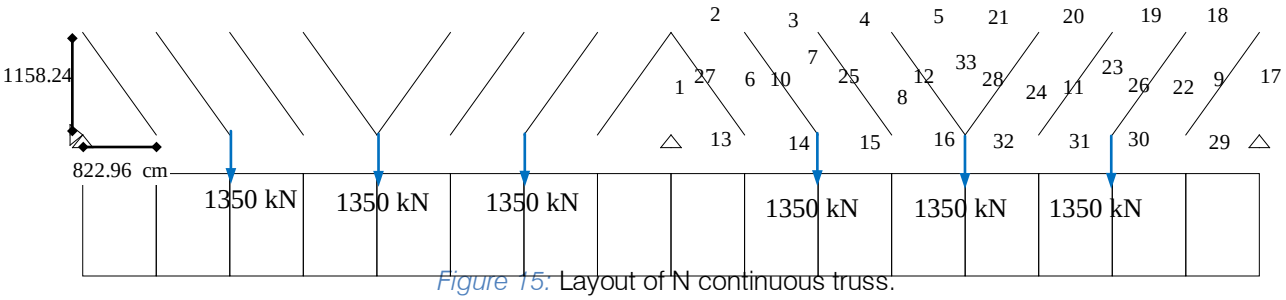


Figure 15: Layout of N continuous truss.

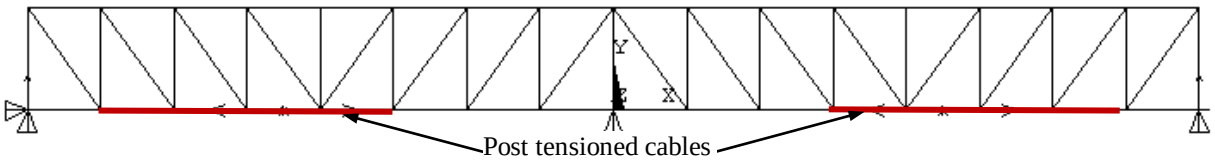


Figure 16: Layout of the 1st technique used for strengthening of the continuous N truss

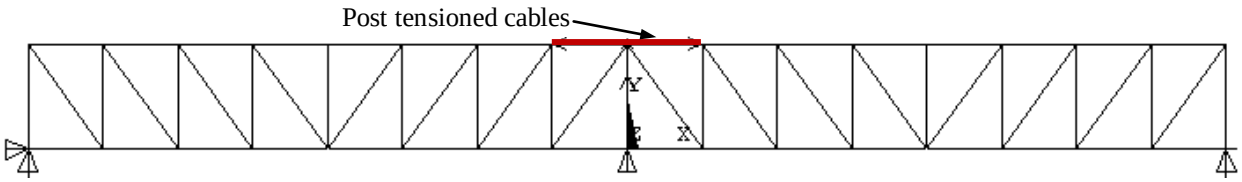


Figure 17: Layout of the 2nd technique used for strengthening of the continuous N truss

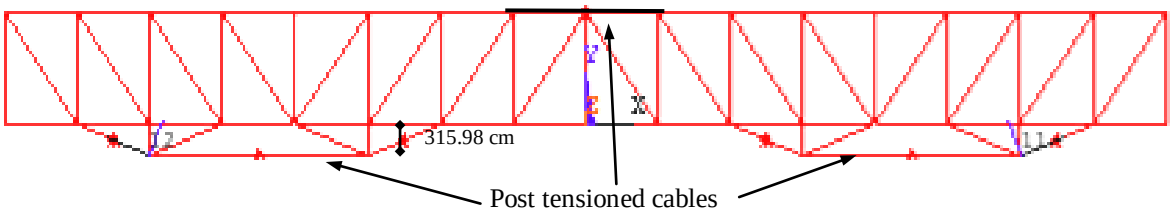


Figure 18: Layout of the 3rd technique used for strengthening of the continuous N truss

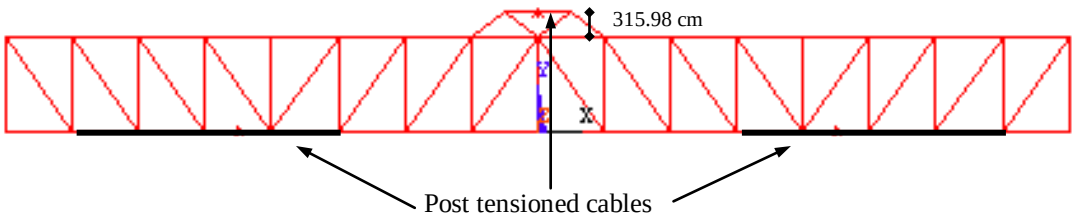


Figure 19: Layout of the 4th technique used for strengthening of the continuous N truss

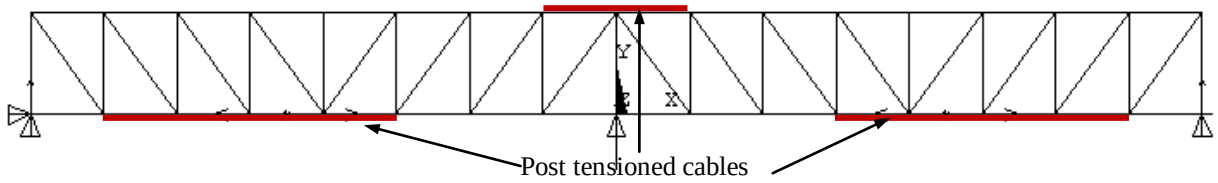


Figure 20: Layout of the 5th technique used for strengthening of the continuous N truss

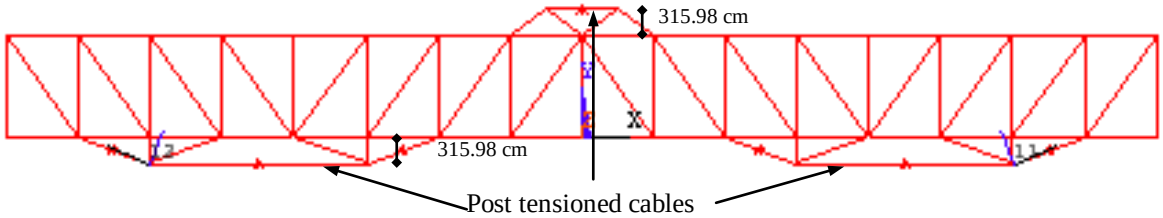


Figure 21: Layout of the 6th technique used for strengthening of the continuous N truss

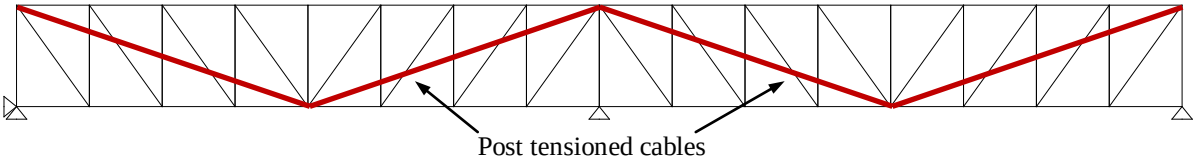


Figure 22: Layout of the 7th technique used for strengthening of the continuous N truss

Table 1: Comparison between the results in Ayyub et al (1990a) and the results obtained by The FE model in this study

Truss Member	N (Ayyub et al 1990a) (kN)	N (FE) (kN)	N + P (Ayyub et al 1990a) (kN)				N + P (FE) (kN)			
			1st Technique	2nd Technique	3rd Technique	4th Technique	1st Technique	2nd Technique	3rd Technique	4th Technique
1	0	0	0	-315	0	0	0	-317.26	0	0
2	0	0	0	-900	0	0	0	-901.71	0	0
3	-2880	-2877.62	-2880	-3330	-2880	-2614.5	-2877.62	-3328.47	-2877.71	-2618.73
4	-2880	-2877.62	-2880	-3330	-2880	-2614.5	-2877.62	-3328.47	-2877.71	-2618.73
5	-3838.5	-3836.84	-3838.5	-3838.5	-3838.5	-3573	-3836.84	-3836.84	-3836.88	-3577.86
6	0	0	0	0	0	-220.5	0	0	0	-220.6
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	-2484	-2484.14	-2349	-2097	-2484	-2119.5	-2484.14	-2094.93	-2484.14	-2125.31
10	2484	2484.14	2484	2097	1710	2394	2484.14	2094.93	1533.29	2395.94
11	-828	-828.05	-828	-441	-828	-828	-828.05	-438.84	-828.05	-827.96
12	828	828.05	828	441	828	828	828.05	438.84	828.05	827.96
13	1440	1438.83	477	1215	1440	828	478.98	1213.38	1438.83	839.75
14	1440	1438.83	477	1215	1440	828	478.98	1213.38	1438.83	839.75
15	3357	3357.23	2398.5	2686.5	2380.5	2596.5	2397.38	2680.97	2381.04	2610.05
16	3357	3357.23	2398.5	2686.5	2380.5	2596.5	2397.38	2680.97	2381.04	2610.05
33	0	0	0	0	0	0	0	0	0	0
Cable	.....	.....	963	954	972	.....	959.85	955.89	964.89	487.31

Table 2: Percentage of reductions in truss members' internal forces after using different post tensioning techniques

Truss's system	1st technique		2nd technique		3rd technique		4th technique		5th technique		6th technique		7th technique	
	% Ten.	% Comp.	% Ten.	% Comp.	% Ten.	% Comp.	% Ten.	% Comp.	% Ten.	% Comp.	% Ten.	% Comp.	% Ten.	% Comp.
N system	9.05	-0.65	2.22	0.14	7.63	0.98	9.5	1.66	7.2	0	9.84	3.19	21.77	-1.42
Warren system	12.8	-15.52	2.75	0.33	9.72	0.94	9.58	-1.17	9.91	0.016	9.31	-0.14	21.63	-12.9

This page is intentionally left blank

Global Journal of Researches in Engineering: E
Civil And Structural Engineering
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Monitoring of the Hill and the Circuit Wall of the Athenian Acropolis Utilizing Optical Fibre Sensors and Accelerographs

By Dr. Elena Kapogianni, Dr. Kalogeras Ioannis, Dr. Prodromos Psarropoulos, Dr. Nikolaos Melis, Ms. Vassiliki Eleftheriou & Professor Emeritus, Michael Sakellariou

National Technical University of Athens

Abstract- The Acropolis of Athens is one of the most prestigious ancient monuments in the world, attracting daily many visitors, and therefore its structural integrity is of paramount importance. During the last decade an accelerographic array has been installed at the Archaeological Site, in order to monitor the seismic response of the Acropolis Hill and the dynamic behaviour of the monuments (including the Circuit Wall), while several optical fibre sensors have been attached at a middle-vertical section of the Wall. In this study, indicative real time recordings of strain and acceleration on the Wall and the Hill with the use of optical fibre sensors and accelerographs, respectively, are presented and discussed. The records aim to investigate the static and dynamic behaviour – distress of the Wall and the Acropolis Hill, taking also into account the prevailing geological conditions. The optical fibre technology, the location of the sensors, as well as the installation methodology applied is also presented. Emphasis is given to the application of real time instrumental monitoring which can be used as a valuable tool to predict potential structural risk.

GJRE-E Classification: *FOR Code: 090609*

MONITORINGOFTHEHILLANDTHECIRCUITWALLOFTHEATHENIANACROPOLISUTILIZINGOPTICALFIBRESENSORSANDACCELEROGRAPHS

Strictly as per the compliance and regulations of :

Monitoring of the Hill and the Circuit Wall of the Athenian Acropolis Utilizing Optical Fibre Sensors and Accelerographs

Dr. Elena Kapogianni [α], Dr. Kalogeras Ioannis [σ], Dr. Prodromos Psarropoulos [ρ], Dr. Nikolaos Melis [ω], Ms. Vassiliki Eleftheriou [¥] & Professor Emeritus, Michael Sakellariou [§]

Abstract- The Acropolis of Athens is one of the most prestigious ancient monuments in the world, attracting daily many visitors, and therefore its structural integrity is of paramount importance. During the last decade an accelerographic array has been installed at the Archaeological Site, in order to monitor the seismic response of the Acropolis Hill and the dynamic behaviour of the monuments (including the Circuit Wall), while several optical fibre sensors have been attached at a middle-vertical section of the Wall. In this study, indicative real time recordings of strain and acceleration on the Wall and the Hill with the use of optical fibre sensors and accelerographs, respectively, are presented and discussed. The records aim to investigate the static and dynamic behaviour – distress of the Wall and the Acropolis Hill, taking also into account the prevailing geological conditions. The optical fibre technology, the location of the sensors, as well as the installation methodology applied is also presented. Emphasis is given to the application of real time instrumental monitoring which can be used as a valuable tool to predict potential structural risk.

List of notation

$\Delta\varepsilon$ strain change
$\Delta\lambda$ wavelength change
$K\varepsilon$ ratio expressing strain-wavelength relation
$K\tau$ ratio expressing strain-temperature relation
$\Delta\tau$ temperature change

I. Introduction

The Acropolis Hill is the most outstanding ancient Greek monumental complex still existing in our time and was chosen due to its geomorphology since the Neolithic period (4000 / 3500-3000 BC) as a place for local residents. It has a height of about 150 m above sea level and 70 m from the level of the city of Athens. Among the standing monuments of the Hill, the Circuit (perimeter) Wall serves a pure geotechnical purpose, since it functions as a typical gravity wall, retaining the backfill that forms the plateau of the Acropolis and has total length of about 800 m and variable height areas 5-20 m. In Figure 1, a panoramic view of the Acropolis Hill from the south-east is depicted.

Author α: Civil Engineer, National Technical University of Athens, Greece. e-mail: elkapogianni@gmail.com
Author σ: Research Director, Geodynamic Institute, National Observatory of Athens, Greece. e-mail: i.kalog@noa.gr
Author ρ: Civil Engineer, National Technical University of Athens. e-mail: prod@central.ntua.gr
Author ω: Research Director, Geodynamic Institute, National Observatory of Athens, Greece. e-mail: nmelis@noa.gr
Author ¥: Architect Engineer, Acropolis Restoration Service, Hellenic Ministry of Culture. e-mail: veleftheriou11@gmail.com
Author §: Professor Emeritus, Michael Sakellariou, Civil Engineer, National Technical University of Athens, Athens, Greece.
e-mail: mgsakel@mail.ntua.gr

Figure 1: Panoramic view of the Athenian Acropolis, where the South Wall (right) and the West Wall (left) are shown

The historical significance of the Archaeological Site, the complexity of the geomorphological conditions in the region, the vulnerability to natural and man-made hazards as well as the need to resolve practical problems encountered during the restoration works have led to the application of various contemporary technologies on the Acropolis Hill and its monuments over the last years. In this framework, multi-disciplinarily instrumental monitoring (via accelerographs and optical fibre sensors) has been included, serving also the extensive restoration works and aiming to real time data gathering for immediate intervention when needed (Sakellariou et al, 2016; Kalogeras et al, 2012).

II. Geology of the Hill and the Perimeter Wall

The Acropolis Hill is geologically composed mainly by limestone overlying the Athenian Schist (Koukis et al., 2015). The Athenian Schist is visible on the main entrance of the archaeological site and less in other positions while the limestone is visible on the hill, when is not covered by artificial embankments, which have been built in order to create the surface level of the hill. The embankments are thicker on the south side and held around the Wall and the limestone karstification has leaded to cavities which facilitate the water flow, further erosion and rock fall phenomena. Figure 2 shows a geological plan view of the Acropolis Hill (Higgins & Higgins, 1996).

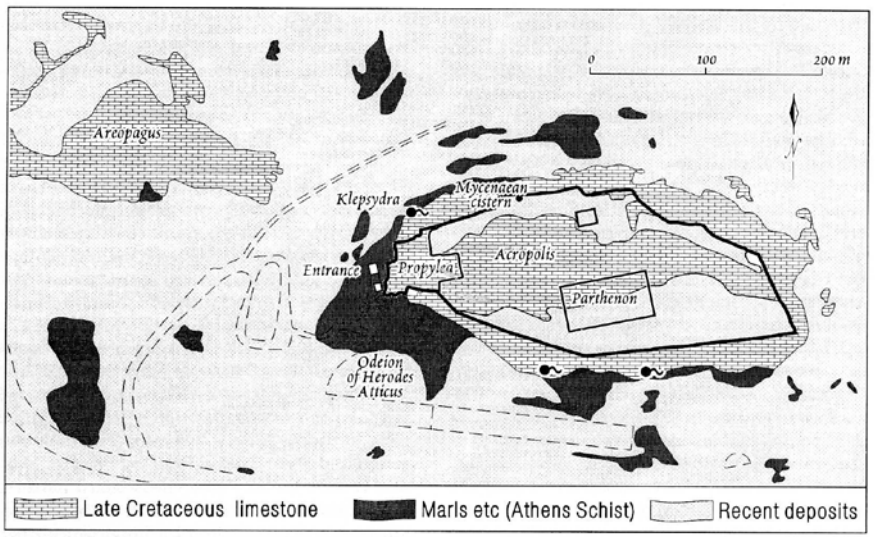


Figure 2: Geological plan view of the Acropolis Hill

The importance of the Perimeter Wall is very high since it provides foundation of other monuments of the hill and the passing of time has seen it undergo numerous damages mainly due to the weather conditions and various types of loading, as well as the human intervention, leading to crack creation and therefore increasing the risk of local and/or extensive structural failures (Ambraseys, 2010; Trikkalinos, 1977). In Figure 3 the central area of the South Wall is noted, which comprises mainly irregular mixed courses made up of ancient marble blocks in second use (spolia) and small stones, added in later repairs.

Figure 3: Central area of the South Wall on the Acropolis Hill

III. Monitoring Infrastructure on the Acropolis Hill

Over the last years, 10 high-quality broadband accelerometers (Guralp CMG-5TD) have been installed on specific locations on the hill, recording in continuous mode on 24-bit digitizers and transmitting data in real-time to the Institute of Geodynamics (NOA) facilities in Thissio and the Acropolis Restoration Service (YSMA) facilities in Plaka, using governmental telecommunication infrastructures (Kalogeras & Egglezos, 2013). The accelerographs were installed, considering the various geotechnical conditions on the hill as well as the specific interest of YSMA for individual sites (Parthenon, South Wall, etc.). In Figure 4 the location of the accelerographs are presented.

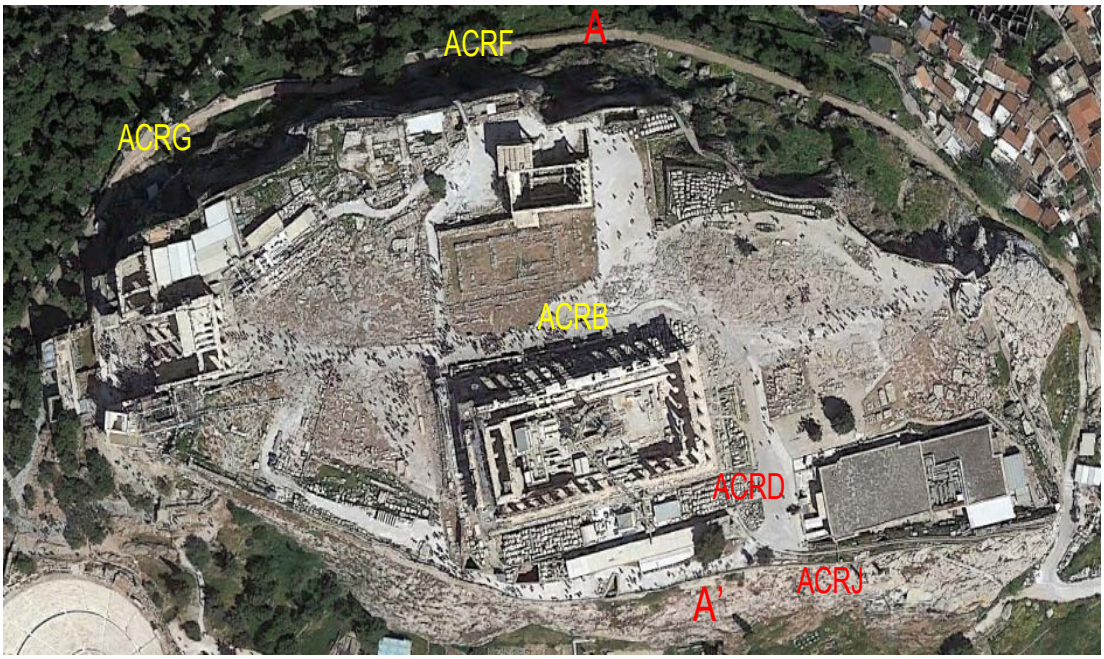


Figure 4: Plan view of the Acropolis Hill showing the location of the ten accelerographs. The red stars correspond to the two accelerographs (ACRD and ACRJ) located on the South Wall (adjacent to the optical fibre sensors array)

In addition, during 2015-2016 a new optical fibre network was developed on the South Wall consisting of eight active strain sensors (Smart Rods) and one acceleration sensor (attached directly on the South Wall), continuously transmitting real time data since June 2016 to date (Kapogianni et al, 2016a; Kapogianni et al, 2016b). The sensors were fixed at predefined positions on the South Wall with the use of stainless steel plates, anchored to the substrate. The critical positions of the optical fibre arrays were defined by analyzing computational models, utilizing the finite element method (Kapogianni et al., 2017) and the area selected for the final installation was near the pre-existing accelerometers ACRD and ACRJ (see Figure 4). Connection in series was achieved via in situ splicing, while strain measurements were made possible with the use of the Optical Sensing Interrogator SM 130. In Figure 5 the location of the new measuring equipment is presented.

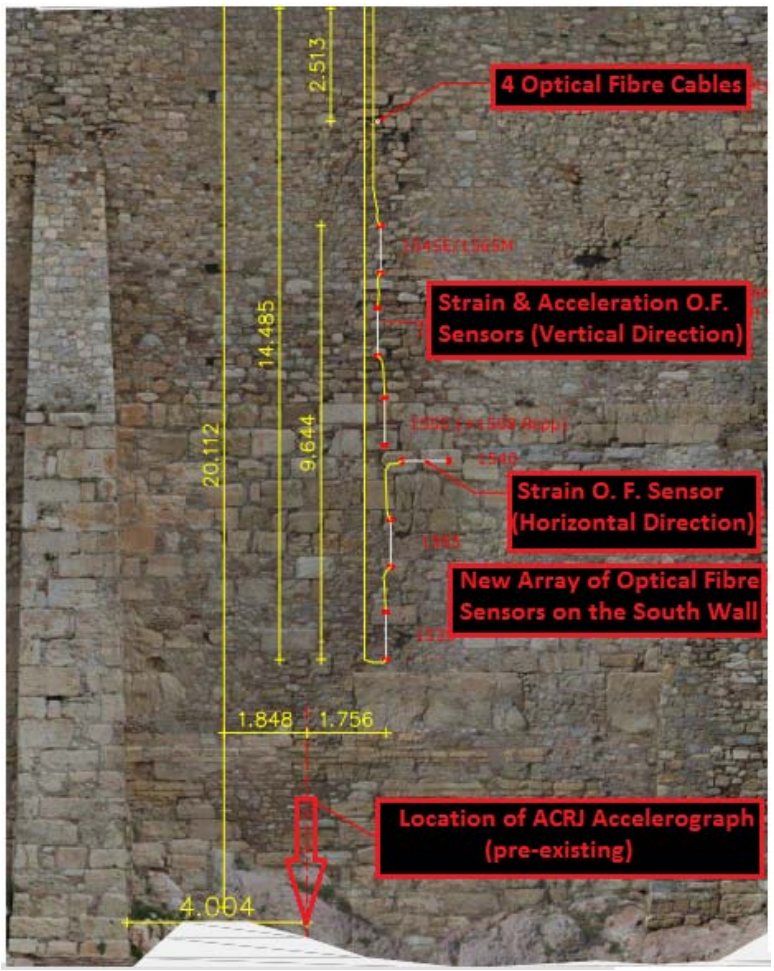


Figure 5: New array of strain and acceleration optical fibre sensors on the South Wall

IV. Optical Fibre Sensors and Acceleration Recordings

Time stamped non-continuous and real-time continuous strain and temperature optical fibre measurements were recorded at various positions on the South Wall. Since various physical phenomena affect the Acropolis Hill and the Perimeter Wall, such as very high and low temperatures, excessive rainfalls, earthquakes, etc., the optical fibre monitoring infrastructure aims to quantify their influence on the monument. Equation 1 is used in order to derive strain measurements from the correspondent wavelength recordings.

$$\Delta\varepsilon = (\Delta\lambda - K\tau * \Delta\tau) / K\varepsilon \quad (1)$$

where

Δ_ε [%] is the strain change;

Δ_λ the wavelength change;

K_ε is a ratio expressing the strain-wavelength relation and is equal to 1.2 picometer (pm)/μstrain for the sensors type that was used for the current study;

$K_\tau \cdot \Delta_\tau$ incorporated the wavelength changes due to the temperature variations, where K_τ is equal to 11.2 pm/C° for the sensors used and Δ_τ is the temperature variation, measured during the tests (starting value and actual-final value).

In Figures 6 and 7 characteristic recordings for time-stamped, non-continuous and real-time continuous strain recordings (including temperature) are presented. The results so far indicate that temperature plays an important role on the strain levels on the Wall. Due to lack of a strong seismic event, no notable acceleration recording has been obtained via the optical fibre sensor. In addition, it is noted that information gained from the non-continuous recordings is of different magnitude and pattern compared to the corresponding ones from the real-time records. In order to derive comprehensive conclusions related to the behavior of the Wall, real-time recordings should be gathered and analyzed for a long period of time and at various positions, including various loading events (e.g. seismic).

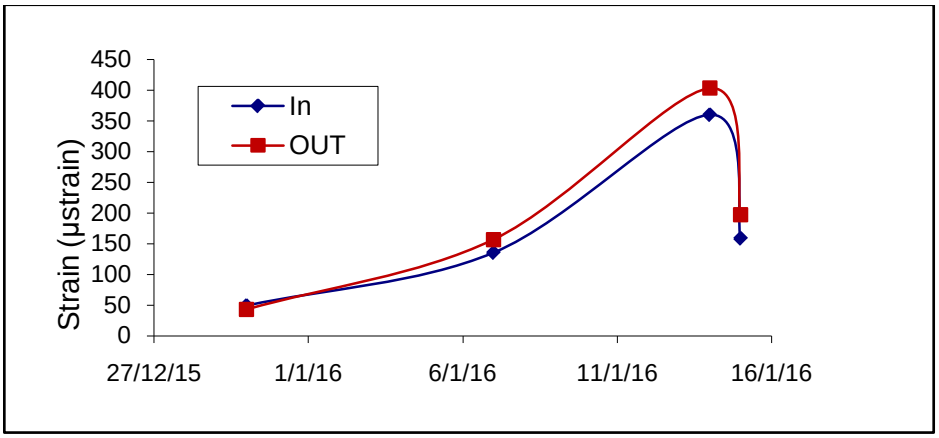


Figure 6: Time-stamped, non-continuous strain recordings on the South Wall

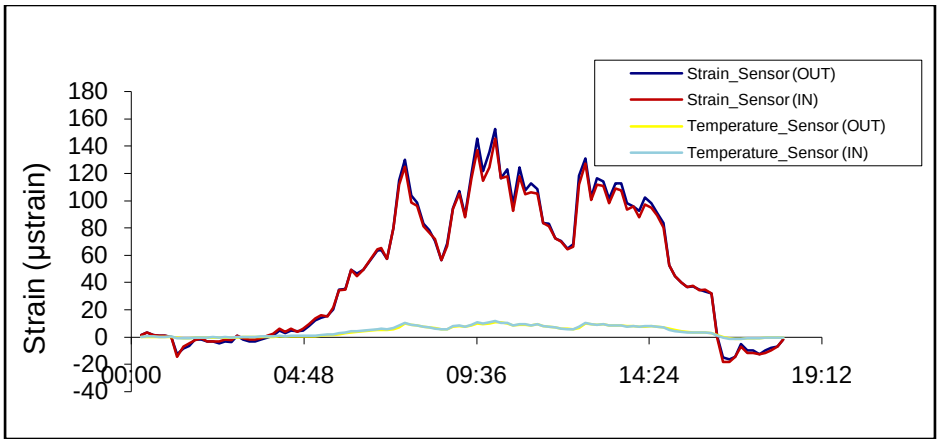


Figure 7: Real-time strain and temperature recordings on the South Wall

Furthermore, real-time continuous strain and temperature recordings are presented in Figures 8a to 8d, for sensors attached on four different locations on the South Wall of the Acropolis Hill. In particular, results via sensors on the top, middle and bottom of the Wall are presented, for an approximately 20-hour period of time. It can be noted that strain increases during the morning and noon and decreases during the night, due to the temperature increase and decrease, respectively. In addition, recordings near the vertical middle section of the Wall are higher, compared to the correspondent values near the top and bottom of the Wall. It should be emphasized that remotely real-time monitoring on various locations on the Wall can provide long-term useful conclusions related to its structural behaviour, especially during various loading events such as seismic, restoration works on the Acropolis site and/or extreme weather conditions.

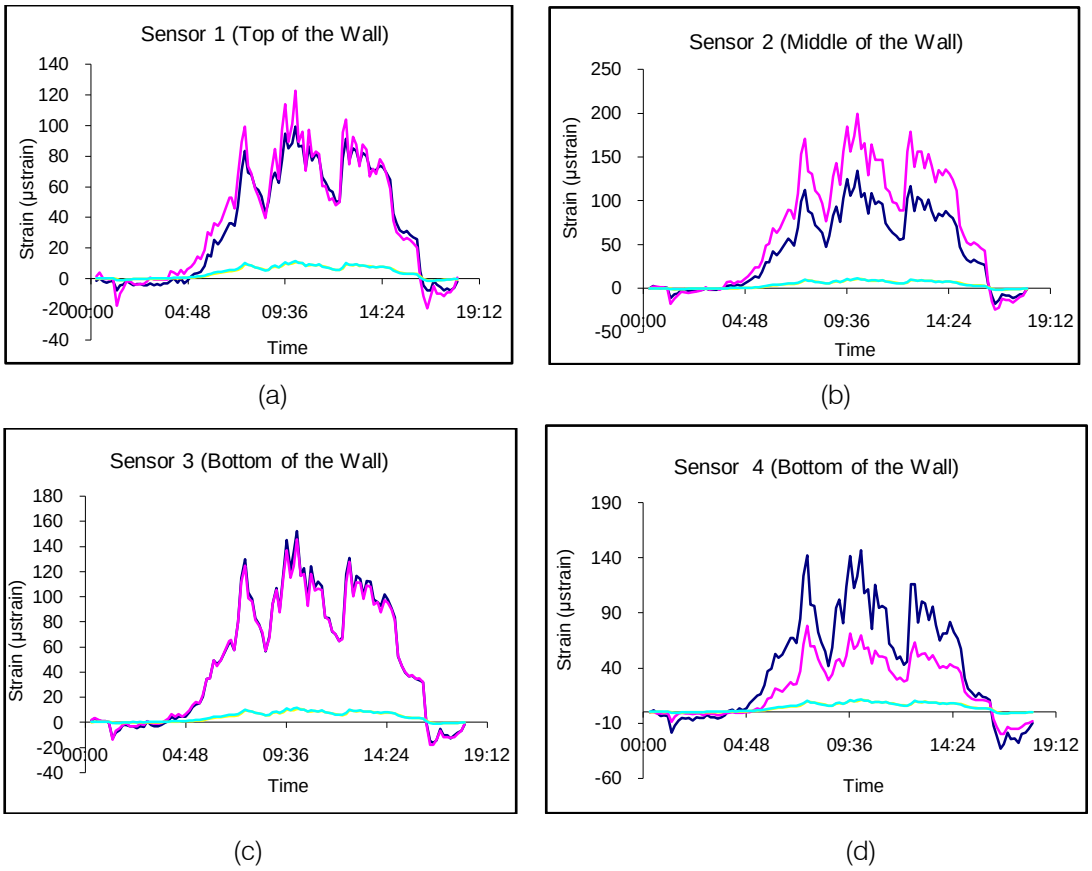
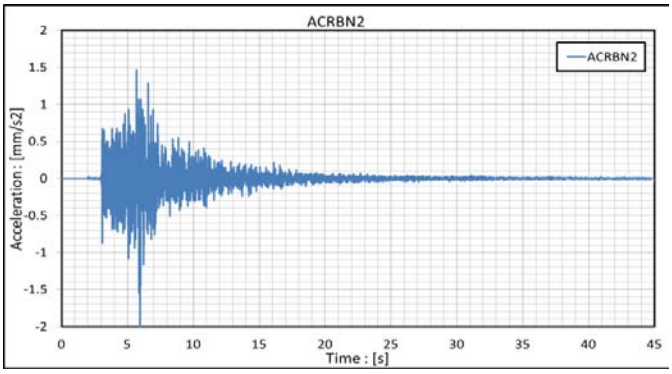


Figure 8: Real-time-stamped strain and temperature recordings at four different locations on the South Wall.

Moreover, since the installation of the first accelerograph in 2006 and of the deployment of the array in two periods (2008 and 2013), many near-field and far-field seismic events have been recorded. In the current study two earthquakes have been considered. The first seismic event (on 05/12/2014) was a small earthquake close to Athens with local magnitude M_L = 2.4 and focal depth of 18.4 km from a distance of 17 km, while the second seismic event (on 24/05/2014) was a strong earthquake almost 300 km away from Athens, close to the island of Samothraki, Northern Aegean, with local magnitude M_L = 6.3 and focal depth 28.3 km. Figure 8 shows the acceleration time-histories of the instrument ARCB (N-S component) recorded during the two aforementioned seismic events.



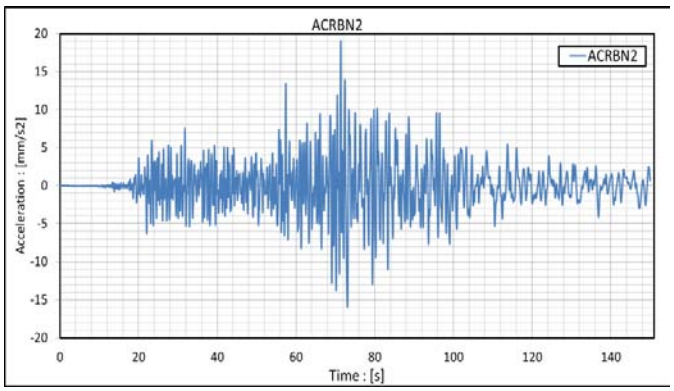


Figure 8: The acceleration time histories recorded by ACRB instrument during the small near-field seismic event (upper) and the strong far-field seismic event (lower)

It is evident that the recorded ground motion of the small near-field seismic event is characterized by very low peak ground acceleration (PGA) levels, short duration and high frequency content, while on the contrary, the recorded ground motion of the strong far-field seismic event is characterized by higher PGA levels, longer duration and lower frequency content.

Figure 9 shows the elastic response spectra of four recorded ground motions (ACRB, ACRF, ACRG and ACRJ) during the two examined seismic events. Judging from the shape of the spectra, it becomes evident that, apart from the obvious great differences between the two seismic events, the discrepancies between the four records during the far-field earthquake are relatively small, while on the contrary, during the near-field event there is a substantial variability referencing to the installation site characteristics: the instruments located at the north side of the hill (i.e. ACRF and ACRG) exhibit higher PGA levels and higher spectral accelerations.

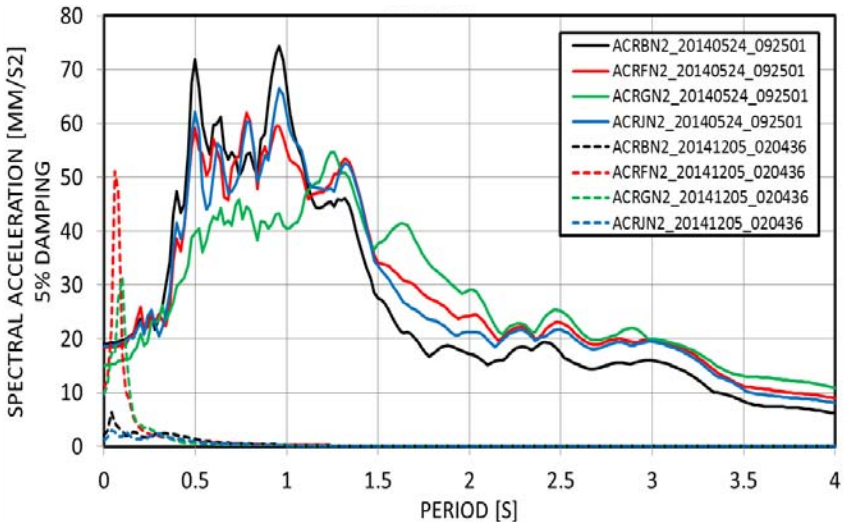


Figure 9: The elastic response spectra of four recorded ground motions during the two examined seismic events. Continuous lines correspond to the far-field event, while dashed lines correspond to the near-field event

V. Conclusions

Structural health monitoring is a rapidly growing scientific area, applied initially to structures of economic importance, historical significance and high risk of failure. The use of measuring systems aims to the creation of intelligent structures such as bridges, buildings, geotechnical constructions, etc., that are instrumented with sensors and other devices, providing important real time information on various locations, necessary for early detection of failures. Through sensors and devices installation, useful real time information is gathered, necessary for early detection of structural problems, during construction and life cycle, contributing to safety and their optimal management.

The current paper is involved with the structural health monitoring of the Acropolis Archaeological Site, via optical fibre sensors installed on the South Wall and accelerographs located on the Hill, continuously transmitting data from various locations. The results so far indicate that temperature plays an important role on the strain levels on the Wall however, due to lack of a strong seismic event, no notable acceleration recording has been obtained. It can be noted that strain increases

during the morning and noon and decreases during the night, due to the temperature increase and decrease respectively. In addition, recordings near the vertical middle section of the Wall are higher, compared to the correspondent ones near the top and bottom of the Wall. Concerning the recorded ground motion via the accelerographs, it is noted that the small near-field seismic event is characterized by very low peak ground acceleration (PGA) levels, short duration and high frequency content, while on the contrary, the recorded ground motion of the strong far-field seismic event is characterized by higher PGA levels, longer duration and lower frequency content.

Concluding, it should be highlighted that remotely real-time monitoring on various locations on the Acropolis Hill can provide long-term useful conclusions related to its structural behaviour, especially during various loading events such as seismic, restoration works on the Acropolis site or/and extreme weather conditions.

VI. Acknowledgements

The first author is grateful for financial support provided by the State Scholarships Foundation of Greece (IKY), during the "IKY Fellowships of Excellence for Postgraduate Studies in Greece-Siemens Programme". The valuable help of Ms. D. Michalopoulou, Head of the Technical Office for the restoration of the Acropolis Wall- Acropolis Restoration should also be acknowledged, as well as the contribution of Civil Engineers S. Giokaris and A. Raftopoulos.

References Références Referencias

1. Ambraseys N., 2010. "On the long-term seismicity of the city of Athens". Proceedings of the Academy of Athens, Vol. A, pp. 81-136.
2. Higgins, M. & Higgins, R., 1996. "A Geological Companion to Greece and the Aegean", London: Gerald Duckworth & Co., pp.26-31.
3. Kalogeras, I., Egglezos, D., 2013. "Strong motion record processing for the Athenian Acropolis seismic response assessment". In Billota, Flora, Lirer and Viggiani (eds). 2nd Int. Symp. Geotechnical Engineering for the Preservation of Monuments and Historic Sites, TC301 IS Napoli, Italy .
4. Kalogeras, I., Evangelidis, C., Melis, N. & Boukouras, K., 2012. "The Athens' Acropolis Strong Motion Array", EGU General Assembly, Geophysical Research Abstracts, vol. 12.EGU 1012-9523, Vienna, Austria.
5. Kapogianni, E., Psarropoulos, P.N., Kalogeras, I., Sakellariou, M.G., 2017. "Athenian Acropolis: Records and numerical simulations for the assessment of the dynamic response of the Hill and the seismic distress of the masonry perimeter Wall". 3rd International Conference on Protection of Historical Constructions, Lisbon, Portugal.
6. Kapogianni, E., Kalogeras, I., Psarropoulos,P., Giokaris, S. & Sakellariou, M., 2016a. "Structural health monitoring of the Athenian Acropolis' Walls via optical fibre sensors, accelerographs and numerical simulations", 10th International Conference on Structural Analysis & Historical Constructions. Leuven, Belgium.
7. Kapogianni, E., Kalogeras, I., Psarropoulos, P.N. Giokaris, S., Raftopoulos, A. & Sakellariou, M. G., 2016b. "Monitoring of the Athenian Acropolis' Walls via optical fibre sensors and accelerographs". International Conference on Smart Infrastructure and Construction (ICSIC) Cambridge, UK (Poster & Oral Presentation).
8. Koukis, G., Pyrgiotis, L.& Kouki, A., 2015. "The Acropolis Hill of Athens: Engineering Geological Investigations and Protective Measures for the Preservation of the Site and the Monuments", Engineering Geology for Society and Territory - Volume 8, pp. 89-93.
9. Sakellariou, M., Kalogeras, I., Kapogianni, E. & Psarropoulos, P., 2016."Investigation of the Structural Response of the Acropolis Wall due to seismic loading, via optical fibre sensors and accelerographs", Report to the Acropolis Restoration Service-YSMA, 85 pages (in Greek).
10. Trikkalinos, I. K., 1977. "Remarks on the published study on the geology of the Acropolis", Proceedings of the Academy of Athens. 12-05, pp. 311-342.

Global Journal of Researches in Engineering: E
Civil And Structural Engineering
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Effect of Extraction Residue on the Properties of Asphalt Binders

By Mouhamed Bayane Bouraima, Xiao-hua Zhang, Shui-wen Zhou & Yanjun Qiu

Southwest Jiaotong University

Abstract- The present study investigates the influence of extraction residue on the properties of aged and unaged asphalt binders. The extraction residues such as trichloroethylene and mineral filler were varied in selected range of percentage (0.5, 1, 1.5 and 2%) and their effect was comprehended in the ductility, softening point, penetration and dynamic shear rheometer tests of 70# grade and SBS modified asphalt binders. The research shows that: (1) the trichloroethylene has more influence on the properties of asphalt binders than the mineral filler; (2) the effect of extraction residue on the properties of 70# grade asphalt is better while their effect on SBS modified asphalt is poor; (3) ageing asphalt binder is less sensitive to extraction residue compare to unaged asphalt binder.

Keywords: trichloroethylene, mineral filler, asphalt binder property, ageing.

GJRE-E Classification: FOR Code: 090599

Strictly as per the compliance and regulations of :

Effect of Extraction Residue on the Properties of Asphalt Binders

Mouhamed Bayane Bouraima [α], Xiao-hua Zhang [σ], Shui-wen Zhou [ρ] & Yanjun Qiu [ω]

Abstract- The present study investigates the influence of extraction residue on the properties of aged and unaged asphalt binders. The extraction residues such as trichloroethylene and mineral filler were varied in selected range of percentage (0.5, 1, 1.5 and 2%) and their effect was comprehended in the ductility, softening point, penetration and dynamic shear rheometer tests of 70# grade and SBS modified asphalt binders. The research shows that: (1) the trichloroethylene has more influence on the properties of asphalt binders than the mineral filler; (2) the effect of extraction residue on the properties of 70# grade asphalt is better while their effect on SBS modified asphalt is poor; (3) ageing asphalt binder is less sensitive to extraction residue compare to unaged asphalt binder.

Keywords: trichloroethylene, mineral filler, asphalt binder property, ageing.

I. Introduction

Over the years, the road building industry has developed asphalt mixtures that have high level of performance. These asphalt mixtures used as paved materials are generally made up aggregates, bituminous binder, air voids and different additives. Due to research purposes in road works sector, it is necessary to separate asphalt mixes into their components. Extraction is an important operation that consists of separating the bituminous binder from the aggregates in reclaimed asphalt or asphalt mixture using a chlorinated solvent. It is mainly used as test to determine the binder properties and content and also to check the grading curve of aggregates after washing and sieving. The extraction process differs in their use of heat method of agitating the mixture and allowable solvents. Different methods have been used for extracting bituminous binders from reclaimed asphalt. They were grouped based on solvent temperature during the process and are categorized into so called hot methods, cold methods, a standardized non-solvent method (EN 12697-39, 2012) and finally automatic method (Montepara and Guiliani, 1999). The hot methods are mostly reflux extraction in which bituminous sample is heated to dissociate the coated aggregates and soxhlet extraction method which is commonly used in organic chemistry. In his paper Collins-Garcia et al., 2000 has mentioned to a less extended hot method for bitumen extraction. Several methods for cold extraction exist and do not use a heat source. Among them, there are agitation method (Ongel and Hugener, 2014; Sugar et al., 2002; Zhao et al., 2015), centrifuge method (Schultz, 1988; Sengoz and Oylumluoglu, 2013; Stroup-Gardiner and Nelson, 2000) and vacuum method (Jones et al., 1969; State of California – Business, transportation and housing agency / California test 310, 2000; Texas DOT Tex-210-F, 2008). Automatic methods (Montepara and Giuliani, 1999) which use different machine models that are available on the market. They have several advantages due to the fast testing and satisfactory experimental working conditions in terms of safety.

Due to the reasons of asphalt content of HMA calculation for quality control and quality acceptance (QC/QA) testing, solvents are still desirable. A number of solvents have been used through the years (Burr et al., 1990). Carbon disulphide (CS2) was initially used since the early 1900s (Bateman & Delp, 1927) followed by benzene (C6H6). Chlorinated solvents like trichloro-ethene (TCE, C2HCl3), 1-1-1-trichloroethane (C2H3Cl3) and dichloromethane (CH2Cl2) became very popular in the 1950s and 1960s (Cipione, Davison, Burr, Glover, & Bullin, 1991) after benzene has been proven to be carcinogenic and its use, bee phase out. TCE was later then found as effective as Benzene based on Abson and Buton (1960) research and thus it became the main replacement of Benzene. Traxler (1967) found that more binder is removed from aggregate when 10-15% of ethanol or methanol added to TCE is used. Cipione et al., 1991 has mentioned that the use of this combination become popular among many researchers at least in US. Several companies have introduced in the market various normal propyl bromide (nPB) solvents as direct substitutes for both TCE and TCA (M. Stroup-Gardiner & J.W. Nelson, 2000).

A number of researchers have shown in the past that asphalt is never completely removed from aggregate, regardless the solvent used. This incomplete extraction results in underestimating the asphalt content between 0.1 to 0.5% (Peterson et al., 1999). This retained asphalt result in significant changes in the recovered asphalt properties (M. Stroup-Gardiner et al., 1994). After extraction, recovery is important since the goal is to evaluate the final properties of the binder. There are two different state-of-the-art methods for

Author α ω: School of Civil Engineering, Southwest Jiaotong Univ., Highway Engineering Key Laboratory of Sichuan Province Chengdu China. e-mail: mouba121286@yahoo.fr
Author σ ρ: Sichuan Provincial Transport Department Highway Planning, Survey, Design and Research Institute Chengdu China.

binder recovery from solvent mixtures used in the European Union: EN 12697-3: Bitumen recovery: Rotary evaporator (2013) and EN 12697-4: Bitumen recovery: Fractionating column (2015). In the US, ASTM D1856: Standard test method for recovery of asphalt from solution by Abson method (ASTM, 2015), introduced in 1933 and ASTM D5404: Standard practice for recovery of asphalt from solution using the rotary evaporator (ASTM, 2012) are the two different methods used for binder recovery. Rotary evaporator is the most method used in EU and US. In his paper tilted recovery and testing of RAP binders from recycled asphalt pavements, Peterson et al., (2000) showed that the rotary evaporator method has to be preferred when it comes to binder tests. It is the method of choice and has been increasingly used since the 1970 because of fewer problems with residual solvent and lower heat need for recovery (Peterson et al., 1999). Rotary evaporator is more prefer to the Abson recovery method since subsequent research showed that the latter left enough residual solvent in the binder which leads to a significant reduction in binder stiffness (Peterson et al., 1999, Abson and Buton, 1960).

Ma Tao et al., 2008 conducted a study with the aim to verify the influence of trichloroethylene, mineral filler and temperature on the reclaimed SBS modified asphalt during the process of extraction and recovery experiments. Different test were then designed and carried out and the corresponding solutions for different influencing factors were presented so that the performance of SBS modified asphalt can be evaluated accurately. They found that the adoption of the upper part of extracting solution from the extraction equipment from Abson recovery experiment after natural sediment for more than 24 hours decrease the adverse effects from residual mineral filler while when there are no equipments for high speed centrifugal separation and pressure filtration. They also indicated after test results that the adverse effects from residual trichloroethylene can be decreased if the temperature of Abson recovery experiment can be reduced to less than 140℃, and the protection gas can be removed, when no condensing liquid trichloroethylene coming out from the end of the orifice of the condenser tube. Physical properties, including softening point, penetration, 15℃ ductility and the 60℃ dynamic viscosity have been carried out by (Liu Zhihui, 2012; Hu Xudong, 2003) on virgin and recovered blank pitch binders using trichloroethylene under well-defined operating conditions. The results obtained from the experiments showed that the penetration degree increased while the softening point and the 60℃ viscosity decrease as well as the asphalt density when the asphalt is recovered. They concluded that the reduction of the physical properties of recovered binder is due to the non-completely removal of the solvent. To investigate the factors that affect the recovery of asphalt, the effect of the trichloroethylene and powder mineral residue at four different percentages (0.5%, 1%, 1.5%, and 2%) on the asphalt properties has been analyzed. In this study, 70# grade asphalt and SBS modified asphalt were used to analyze the effect of residue on the properties of asphalt. A large number of experiments have shown that the possible residual residues for the recovery of asphalt from rotary evaporators include mineral filler and trichloroethylene, which are mainly aimed at the effects of residuals on the properties of asphalt. To investigate the factors that affect the recovery of asphalt, the effect of the trichloroethylene and powder mineral residue at four different percentages (0.5%, 1%, 1.5%, and 2%) on the asphalt properties has been analyzed. In this study, 70# grade asphalt and SBS modified asphalt were used to analyze the effect of residue on the properties of asphalt.

II. Experimental Program

Prior to the test, 150g of each type of asphalt is heated under constant temperature: 70# grade asphalt to about 150℃ and SBS modified asphalt to about 160℃. Then, the desired content of trichloroethylene and mineral filler is added to the asphalt, and a glass rod is used to stir the asphalt. When the trichloroethylene is added, the quantity of trichloroethylene is needed to be quickly dispersed into the asphalt because of the rapid evaporation of trichloroethylene.

In this study, the ductility test is performed at 10℃ for unaged 70# grade asphalt while it is at 5℃ for unaged SBS modified asphalt. The dynamic shear rheometer test DSR is performed at 64℃ for unaged 70#grade asphalt while it is 76℃ for SBS bitumen. The penetration test temperature is at 25℃. The 70# grade asphalt and SBS modified asphalt were aged by the pressure aging vessel process (PAV), then the effect of extraction residue on the properties of aged asphalt was studied. After the PAV process, the ductility test temperature for both ageing asphalt is 10 ℃.

III. Results and Discussion

a) *Analysis of the Effect of Extraction Residue on the Properties of 70# grade asphalt and SBS Modified Asphalt*

i. *Effect of the extraction residue on softening point*

The effect of the extraction residue on the softening point of asphalt is shown from Fig. 1 to Fig. 4. It can be clearly seen that the softening point of both asphalt binders increases with the increase of mineral filler residue while it gradually decreases with increase in the amount of trichloroethylene. From the development of the trend line, it can be seen that the effect of the extraction residue on the softening point of the 70# grade asphalt is higher than that of SBS modified asphalt. From the numerical point of view for each 0.1% increase in mineral filler residue, the softening point of

70# grade asphalt increased by about 0.066℃ while that of SBS modified asphalt increased by about 0.061 ℃. An increase of 0.1% in trichloroethylene results to a decreased of 0.307 ℃ and 0.197 ℃ on the softening point of 70# grade asphalt and SBS modified asphalt respectively. It can be shown that the effect of mineral filler residue on the softening point of 70# grade asphalt is close to that of SBS modified asphalt, but the effect of trichloroethylene on softening point of 70# grade asphalt is much greater than that of SBS modified asphalt. It can be concluded that the trichloroethylene has a greater effect on the softening point of the asphalt than the mineral filler.

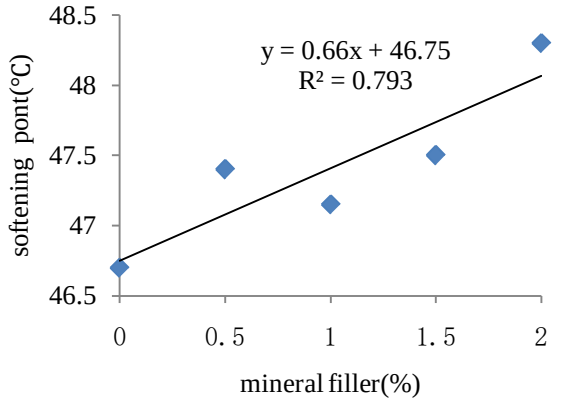


Fig.1: Effect of mineral filler content on the softening point of 70# grade asphalt

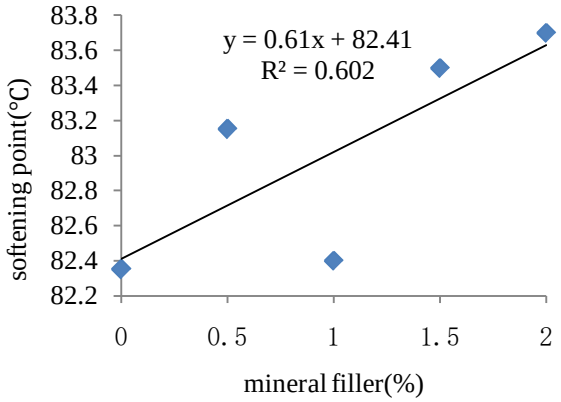


Fig. 2: Effect of mineral filler content on the softening point of SBS modified asphalt

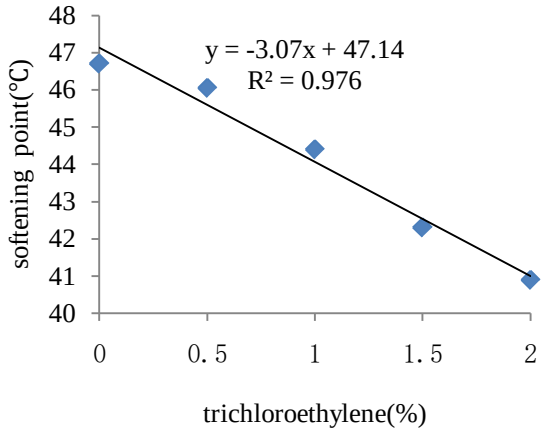


Fig. 3: Effect of trichloroethylene content on the softening point of 70# grade asphalt

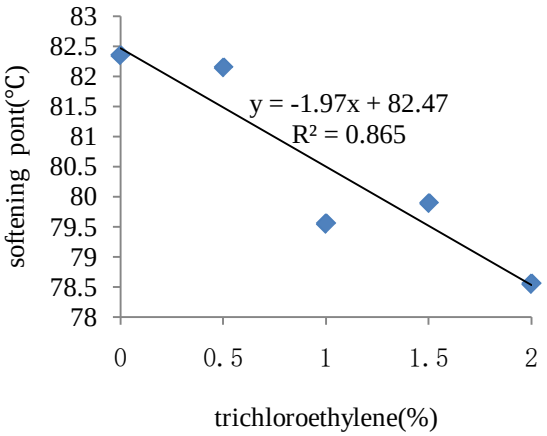


Fig. 4: Effect of trichloroethylene content on the softening point of SBS modified asphalt

ii. *Effect of extraction residue on penetration*

The effect of the extraction residue on the penetration of the asphalt is shown from Figures 5 to 8. It can be clearly seen that the penetration of both asphalt is gradually reduced with the increase of mineral filler residue content while it is the opposite trend with the increase in the amount of trichloroethylene. From the development of the trend line, the effect of extraction residue on the penetration of 70# grade asphalt is stronger than that of SBS modified asphalt. From the numerical point of view, the penetration rate of 70# grade asphalt decreased by about 0.237 (0.1mm)that of SBS modified asphalt decreased by about 0.120 (0.1mm) when the residue of mineral filler increased by 0.1%. With the increase of trichloroethylene by 0.1%, the penetration of 70# grade asphalt increased by about 3.991 (0.1mm) and that of SBS modified asphalt increased by about 0.921 (0.1mm. It can be explained that the influence of mineral filler residue on the penetration of 70# grade asphalt is much greater than that of SBS modified asphalt and the trichloroethylene effect is higher than that of mineral filler for both asphalt binders.

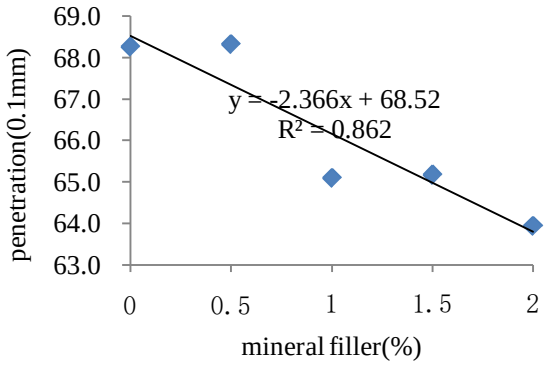


Fig. 5: Effect of mineral filler content on the penetration of 70# grade asphalt

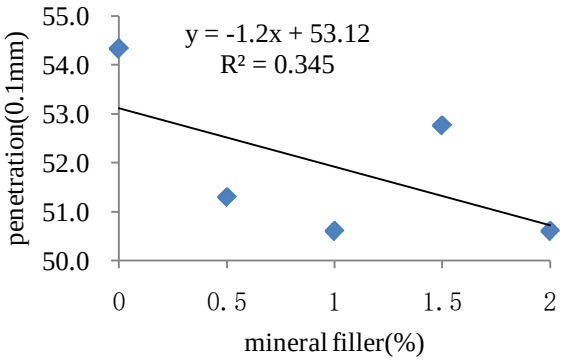


Fig. 6: Effect of mineral filler content on the penetration of SBS modified Asphalt

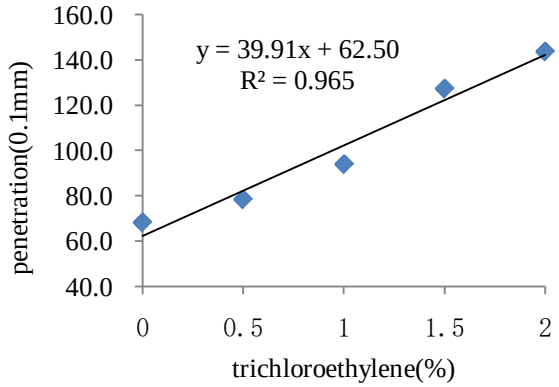


Fig. 7: Effect of trichloroethylene content on the penetration of 70# grade asphalt

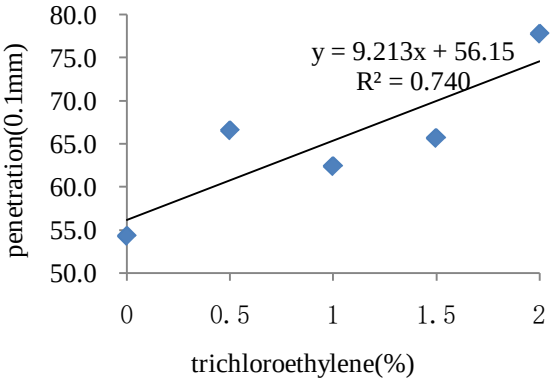


Fig. 8: Effect of trichloroethylene content on the penetration of SBS modified asphalt

iii. *Effect of extraction residue on ductility*

The effect of the extraction residue on the ductility of the asphalt is shown from Figures 9 to 12. It can be clearly seen that the ductility of 70# grade asphalt and SBS modified asphalt is gradually reduced with the increase of mineral filler while it is the opposite trend with the increase in the content of trichloroethylene. From the numerical point of view, each 0.1% increase in the mineral filler residue results in the decreased of 1.039cmand 0.15cm in the ductility of 70# grade asphalt and SBS modified asphalt respectively.

As long as the trichloroethylene residual increase by 0.5%, the 10 ℃ ductility of 70# grade asphalt increased from 41.9cm to a value greater than 160cm, while the 5 ℃ ductility increased from 30.1cm to 31.5cm for SBS modified asphalt Relatively speaking, the influence of trichloroethylene on the ductility of 70#grade asphalt is very obvious while it has a little effect on the SBS modified asphalt, and the mineral filler residue has the same influence rule.

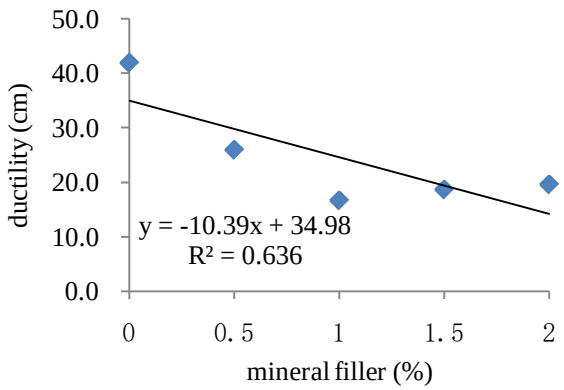


Fig. 9: Effect of mineral filler content on ductility of 70# grade asphalt

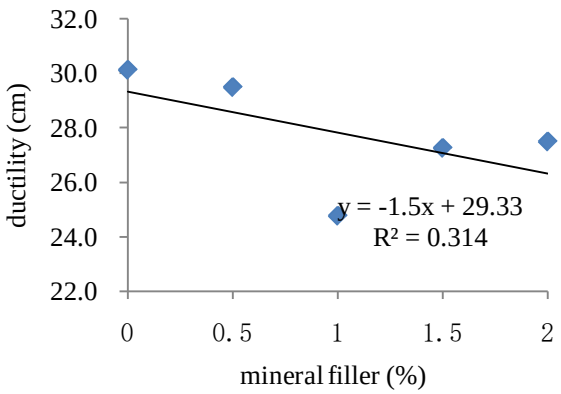


Fig. 10: Effect of mineral filler content on ductility of SBS modified asphalt

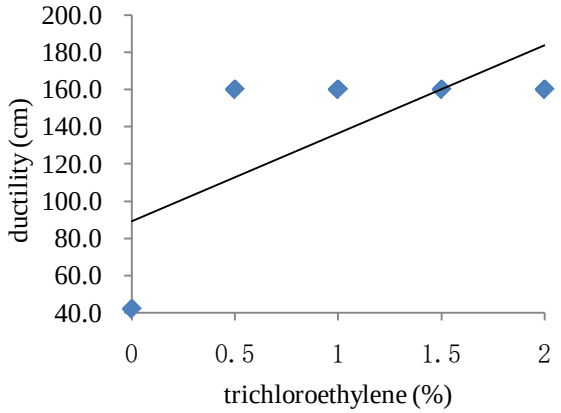


Fig. 11: Effect of trichloroethylene content on ductility of 70# grade asphalt

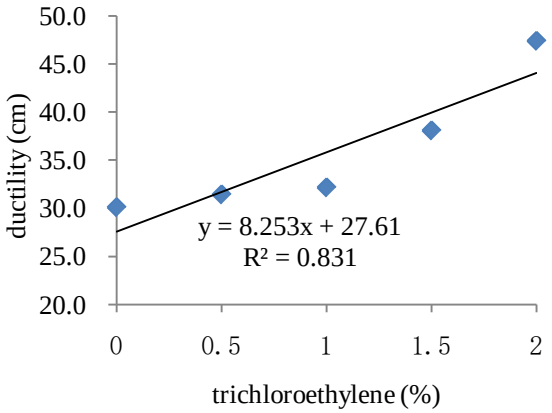


Fig.12: Effect of trichloroethylene content on ductility of SBS modified asphalt

iv. *Effect of extraction residue on rutting factor (DSR)*

The effect of the extraction residue on the asphalt rutting factor is shown from Figures 13 to 16. It can be seen that the rutting factor of asphalt increases with the increase of mineral filler, and the rutting factor of 70# grade asphalt increases by about 14.4Pa for each 0.1% increase in mineral filler content while that of SBS modified asphalt increases by about 8.9Pa. The rutting factor of asphalt has a significant downward trend with the increase in the amount of trichloroethylene. The rutting factor of 70# grade asphalt is reduced by about 42 Pa for each 0.1% increase in the amount of trichloroethylene and that of SBS modified asphalt is reduced by about 13.5 Pa.

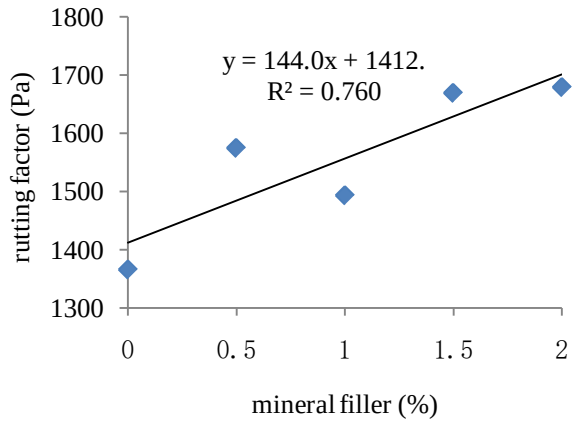


Fig. 13: Effect of mineral filler content on rutting factors of 70# grade asphalt

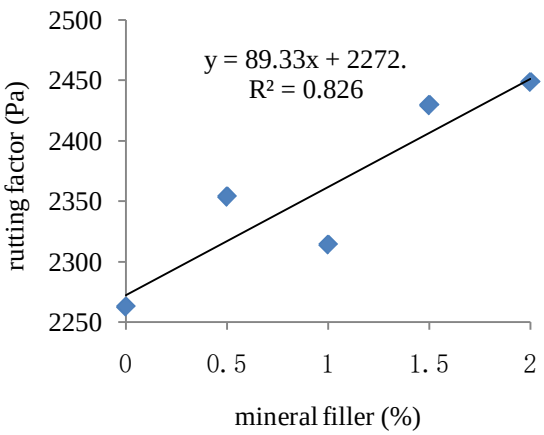


Fig. 14: Effect of mineral filler content on rutting factors of SBS modified asphalt

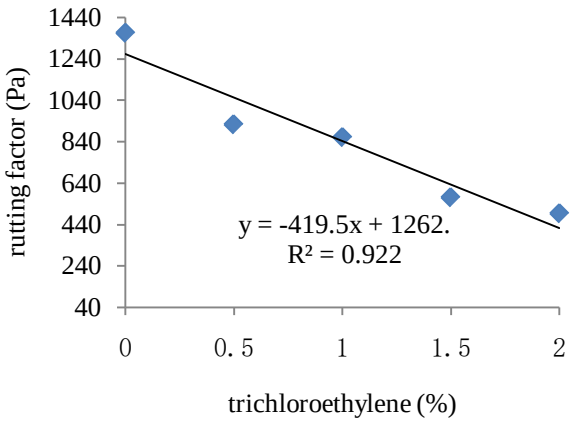


Fig.15: Effect of trichloroethylene content on rutting factors of 70# grade asphalt

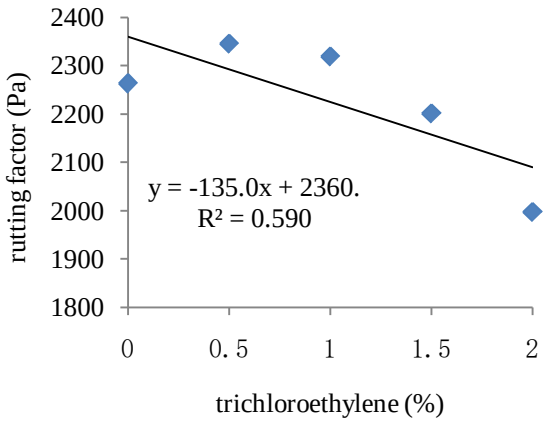


Fig. 16: Effect of trichloroethylene content on rutting factors of SBS modified asphalt

b) Analysis of the effect of extraction residue on the properties of 70# grade asphalt and SBS modified asphalt after ageing (PAV)

i. *Effect of extraction residue on softening point*

The effect of the extracted residue on the softening point of asphalt after PAV aging is shown from Fig. 17 to Fig 20. It can be clearly seen that the softening point of the asphalt gradually increased with the increase of the content of the mineral filler. With the increase of the content of trichloroethylene, the softening point of the aged asphalt gradually decreases. From the numerical point of view, the softening point of 70# gradeaging asphalt increased by about 0.019 ℃, 0.3 times less than the temperature sensitivity of the unaged asphalt while that of the SBS aging asphalt increased by about 0.093 ℃, 1.41 times more than the temperature sensitivity of the unaged asphalt for an increase of 0.1% of mineral filler. For an increase of 0.1% of trichloroethylene, the softening point of 70# gradeaged asphalt decreased by about 0.238 ℃, 0.78 times less than the temperature sensitivity of the unaged asphalt, the softening point of SBS modified asphalt decreased by about 0.098 ℃, 0.5 times less than the temperature sensitivity of the unaged asphalt. It can be explained that the softening point of aged asphalt is different from that of unagedasphalt to the sensitivity of mineral residue and trichloroethylene. SBS aging asphalt is more sensitive, while the sensitivity of 70# grade aging asphalt is weaker. In addition, we can see that the softening point of the aging asphalt is more sensitive to trichloroethylene than the mineral filler. The experimental data on the effect of slag on the softening point of aging asphalt is more discrete than that of trichloroethylene. It is shown that if the extraction of asphalt contains mineral filler, it will affect the parallelism of the results of asphalt softening point test.

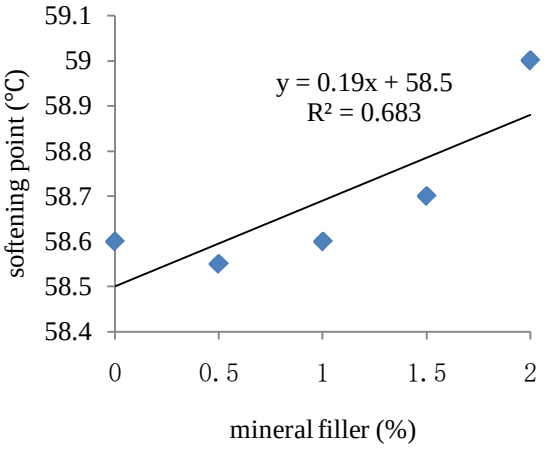


Fig. 17: Effect of mineral filler content on softening point of 70# grade asphalt

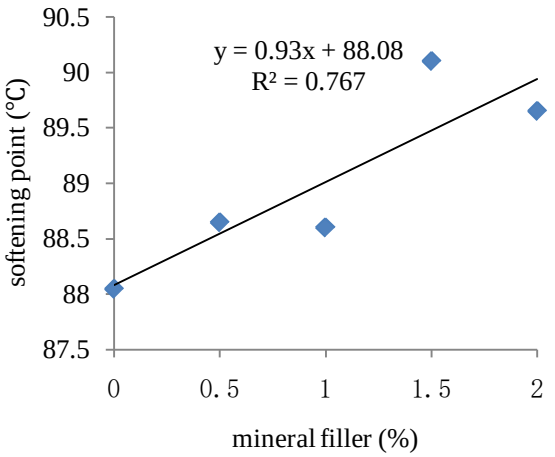


Fig. 18: Effect of mineral filler content on softening point of SBS modified asphalt

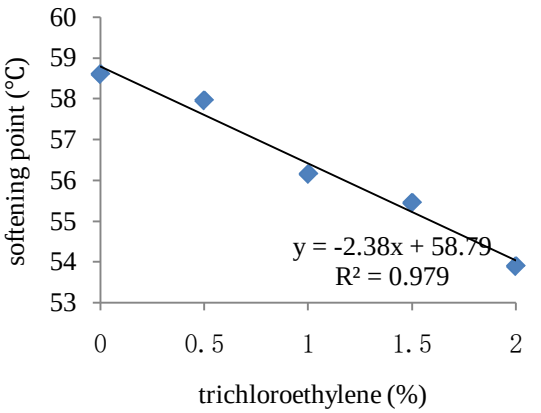


Fig. 19: Effect of trichloroethylene content on softening point of 70# grade asphalt

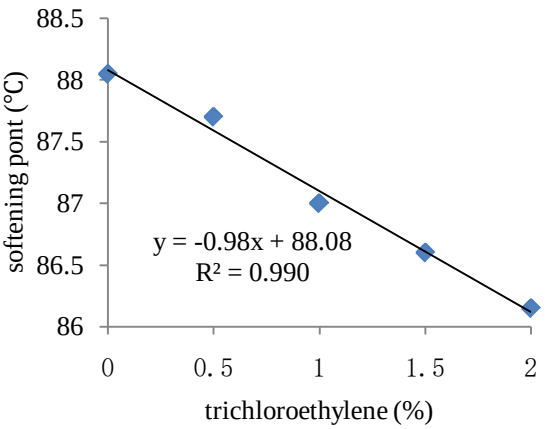


Fig. 20: Effect of trichloroethylene content on softening point of SBS modified asphalt

ii. *Effect of extraction residue on penetration*

The effect of the extraction residue on the penetration of PAV aged asphalt is shown from Fig. 21 to Fig 24. It can be clearly seen that the penetration of aged asphalt decreases with the increase of the content of mineral filler. With the increase of the content of

trichloroethylene, the penetration of aged asphalt increases gradually. From the point of view, the increase in mineral filler content by 0.1%, the penetration of the 70# grade aging asphalt reduce by about 0.033 (0.1mm), is less 0.14 times than the temperature sensitivity of the original asphalt; the penetration SBS modified asphalt reduction of about 0.120 (0.1 mm), which is twice less sensitive as the original asphalt. For every 0.1 % increase in the residual amount of trichloroethylene, the penetration of 70# grade ageing asphalt increased by about 0.75 (0.1mm), 0.19 times the sensitivity of the original bitumen. The penetration of SBS modified asphalt increases by about 0.27 (0.1mm), which is 0.289 times of the original asphalt sensitivity. It can be explained that the needle penetration index of aging asphalt is less sensitive than that of the original bitumen to the amount of trichloroethylene and mineral filler. The effect of mineral filler on the penetration of aging asphalt is also discretized, as well as the parallelism of the softening point of the aging asphalt.

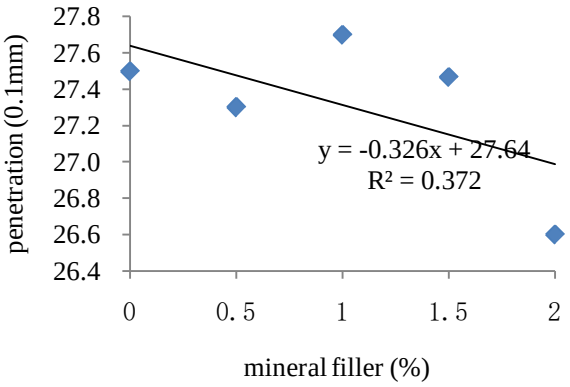


Fig. 21: Effect of mineral filler content on penetration of 70# grade asphalt

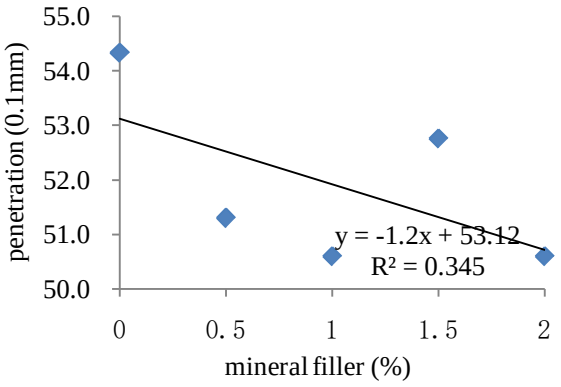


Fig. 22: Effect of mineral filler content on penetration of SBS modified asphalt

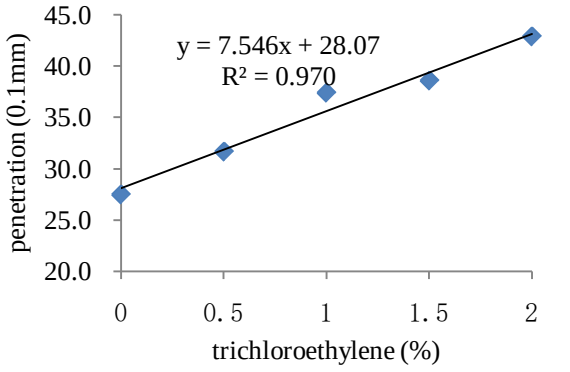


Fig. 23: Effect of trichloroethylene content on penetration of 70# grade asphalt

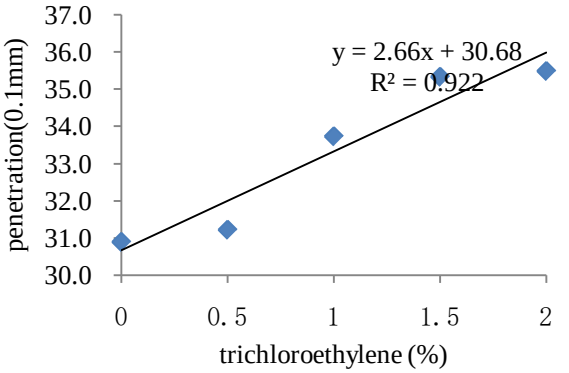


Fig. 24: Effect of trichloroethylene content on penetration of SBS modified asphalt

iii. *Effect of extraction residue on ductility*

The effects of extraction residues on the ductility of aging asphalt are shown from Fig.25 to Fig.28. It can be clearly seen that the ductility of aging asphalt is gradually reduced with the increase of the mineral filler. With the increase of the residual amount of trichloroethylene, it increased. From the numerical point of view, the increase of 0.1% in mineral filler results in decreased by about 0.011cm on the 15℃ ductility of 70# grade aging asphalt, 0.0106 times less than the temperature sensitivity of the unaged 70# gradeasphalt; and the 10℃ductility of SBS modified is about 0.053cm, 0.35 times less sensitive than that of the original asphalt. The 10℃ ductility of 70# grade aging asphalt increased by 0.294cm with the increased by 0.1% of amount of trichloroethylene, while the 10℃ ductility of the original asphalt can increase from 41.9cm to a value greater than 160cm as long as the 0.5% of trichloroethylene is added. When the content of trichloroethylene is 0.5%, 10℃ ductility of SBS aging asphalt increases from 12.7cm to 13.2cm, while that of original asphalt increases from 30.1cm to 31.5cm. Relatively speaking, asphalt aging reduces the sensitivity to trichloroethylene and mineral content. The effect of mineral filler on the stiffness of the asphalt is still discrete relative to the effect of trichloroethylene, which will also affect the parallelism of the results of the ductility test.

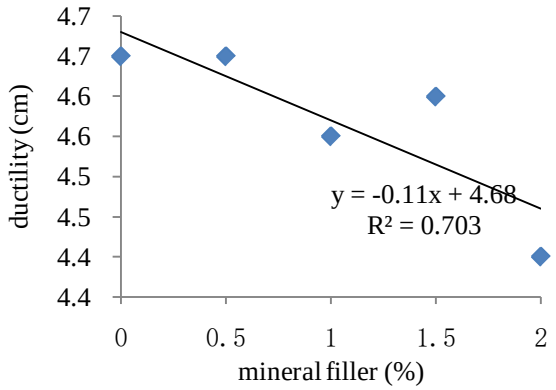


Fig. 25: Effect of mineral content on ductility of 70# grade asphalt

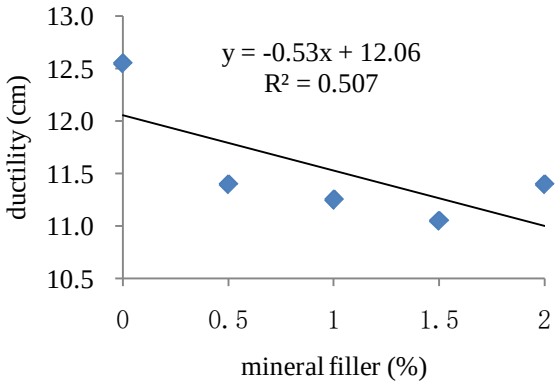


Fig. 26: Effect of mineral content on ductility of SBS modified asphalt

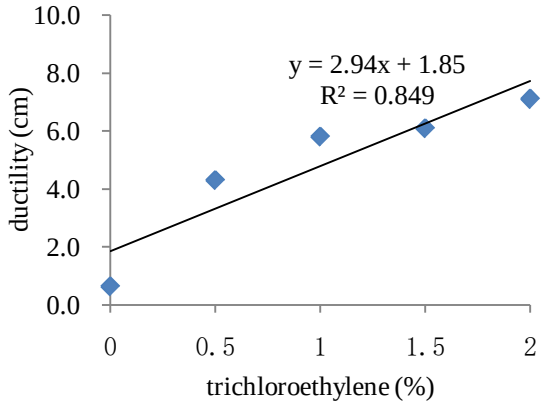


Fig. 27: Effect of trichloroethylene content on ductility of 70# grade asphalt

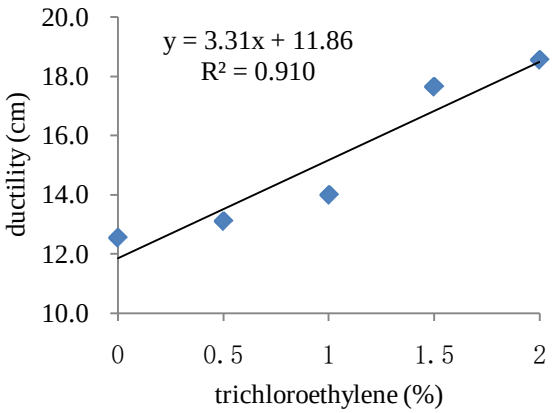


Fig. 28: Effect of trichloroethylene content on ductility of SBS modified asphalt

iv. *Effects of extraction residue on rutting factors (DSR)*

The influence of the extraction residue on the rutting factor of aged asphalt is shown from Fig.29 to Fig 32. It can be seen that the rutting factor of asphalt aging gradually increased with 0.1% increase of the mineral filler content, the rutting factor of the 70# grade aging asphalt increased about 35.53 Pa, is 2.5 times that of the original asphalt sensitivity; the rut factor of SBS aging asphalt increased about 1.72 Pa, 0.2 times that of the same original asphalt sensitivity. Rutting factor of aging asphalt has significant decline along with the increasing trichloroethylene every 0.1% increase in trichloroethylene results in 130.9 Pa of the 70# grade asphalt, which is 3.12 times the sensitivity rut factor of the original asphalt; the ruts factor of the ageing SBS modified asphalt is 48.5 Pa, 3.59 times that of the sensitivity rut factor of the original asphalt.

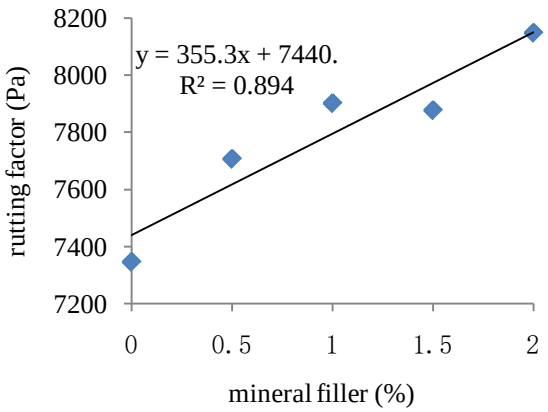


Fig. 29: Effect of mineral content on rutting factor of 70# grade asphalt

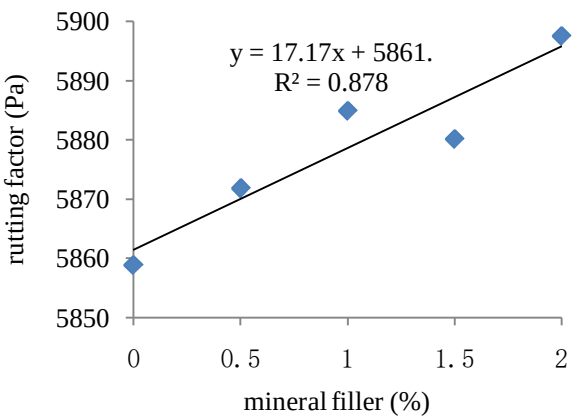


Fig. 30: Effect of mineral content on rutting factor of SBS modified asphalt

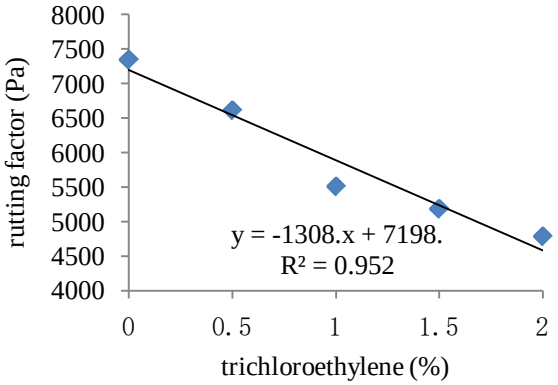


Fig. 31: Effect of trichloroethylene content on rutting factor of 70# grade asphalt

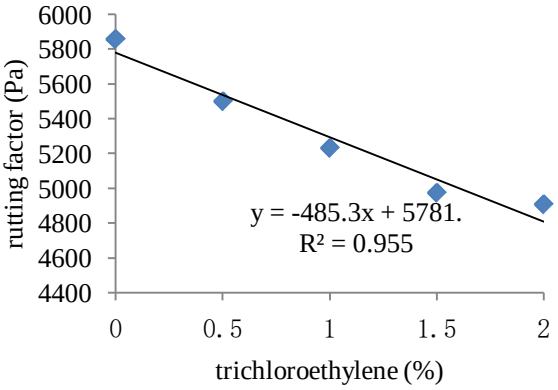


Fig. 32: Effect of trichloroethylene content on rutting factor of SBS modified asphalt

IV. Conclusions

In this study, the effect of the trichloroethylene and powder mineral residue at four different percentages (0.5%, 1%, 1.5%, and 2%) on the 70# grade asphalt and SBS modified asphalt properties has been analyzed. The following conclusions have be drawn:

1. Trichloroethylene reduces the softening point and rutting factors of the asphalt, increasing the penetration and ductility of the asphalt; the mineral filler residual reduces the asphalt ductility and penetration, and improves the softening point and rutting factor.
2. Under the same amount of extraction residue, the trichloroethylene has more influence on the penetration, softening point, ductility and rutting factor of asphalt than mineral filler.
3. The influence of trichloroethylene on the properties of 70# grade asphalt is greater than that of SBS modified asphalt. The influence of mineral filler on the properties of two kinds of asphalt is quite equivalent
4. The effect of extraction residue on the properties of 70# grade asphalt is better, and its effect on SBS modified asphalt is poor.
5. Most of the indicators indexes of ageing asphalt are less sensitive to extraction residue than original asphalt.
6. When the content of the mineral filler is small, it cannot uniformly influence the asphalt when it is dispersed. The mineral filler will affect the parallelism of the asphalt index test results, and the test results will be relatively discrete. It has then a little effect on the test result.

V. Acknowledgements

Special thanks to the Sichuan provincial Transport Department Highway Planning Survey, Design, And Research Institute by providing the required materials and devices needed to ensure that this work is successfully accomplished.

References Références Referencias

1. Ongel, A., Hugener, M., 2014. Aging of bituminous mixes for rap simulation. Construction and Building Materials 68, 49–54.
2. Sauger, E., Vignard, N., Detrez, M., 2002. Etude du remplacement des solvants chlorés au laboratoire: Nettoyage du matériel et extraction de liants bitumineux. Laboratoire Central des Ponts et Chaussées -Centre de Nantes CHG05896, Littérature grise Boîte 309.
3. Zhao, S., Huang, B., Shu, X., 2015. Investigation on binder homogeneity of RAP/RAS mixtures through staged extraction. Construction and Building Materials 82, 184–191.
4. Schultz, R.L., 1988. Asphalt extraction study. Task report WA-RD 165.1.
5. Sengoz, B., Oylumluoglu, J., 2013. Utilization of recycled asphalt concrete with different warm mix asphalt additives prepared with different penetration grades bitumen. Construction and Building Materials 45, 173–183.
6. Bateman, J. H., & Delp, C. (1927). The recovery and examination of the asphalt in asphaltic paving mixtures. University Bulletin. Louisiana State University and Agricultural and Mechanical College.
7. Cipione, C., Davison, R., Burr, B., Glover, C., & Bullin, J. (1991). Evaluation of solvents for extraction of residual asphalt from aggregates. Transportation Research Record, 1323, 47–52.
8. Collins-Garcia, H., Tia, M., Roque, R., Choubane, B. (2000). Alternative solvent for reducing health and environmental hazards in extracting asphalt: An evaluation. Transportation Research Record: Journal of the Transportation Research Board 1712, 79–85.
9. Abson, G., & Burton, C. (1960). The use of chlorinated solvents in the Abson recovery method. Association of Asphalt Paving Technologists, Proceedings, 29, 246–252.
10. Traxler, R. N. (1967). Changes in asphalt cements during preparation, laying and service bituminous

pavements. Association of Asphalt Paving Technologists, Proceedings, 36, 541–561. Retrieved from https://trid.trb.org/view/100879.
11. Stroup-Gardiner, M., Newcomb, D., Savage, D(1994). Defining Specification Limits with Respect to Testing Variability. Association of Asphalt Paving Technologists, Vol. 63, 1994.
12. Stroup-Gardiner M, Nelson J W (2000). Use of normal propyl bromide solvents for extraction and recovery of asphalt cements [R]. Aubum USA: Aubum University Press.
13. EN 12697-3. (2013). bituminous mixtures – Test methods for hot mix asphalt – Part 3: Bitumen recovery: Rotary evaporator. Brussels: CEN.
14. EN 12697-4. (2015). bituminous mixtures – Test methods for hot mix asphalt EN 12697-4 Part 4: Bitumen recovery: Fractionating column. Brussels: CEN.
15. ASTMD5404/D5404M-12. (2012). Standard practice for recovery of asphalt from solution using the rotary evaporator. West Conshohocken: ASTM International. Doi: doi: 10.1520/D1856-09R15.
16. ASTM D1856-09. (2015). Standard test method for recovery of asphalt from solution by Abson method. West Conshohocken: ASTM International. Doi: doi: 10.1520/D1856-09R15.
17. Peterson, R.L., Soleymani, H.R., Anderson, R.M., &McDaniel, R.S. (2000). Recovery and testing of RAP binders from recycled asphalt pavements. Association of Asphalt Paving Technologists, proceedings, 69, 72–91. Retrieved from https://trid.trb.org/view/675392.
18. Peterson, R.L., Soleymani, H.R., Anderson, R.M., and McDaniel, R.S (1999). Recovery and Testing of RAP Binders from Recycled Asphalt Pavement. Research paper, the Asphalt Institute, January, 1999.
19. Abson, G. and C. Burton (1960). "The Use of Chlorinated Solvents in the Abson Recovery Method." Proceedings, Association of Asphalt Paving Technologists, Volume 29, St. Paul, MN.
20. Jones, G., Wiley, M., Smith, R., 1969. Vacuum Extraction of Bitumen from Pavement Mixtures, in: Rapid Test Methods for Determination of Bitumen Content in Bituminous Mixtures. ASTM International.
21. Montepara, A., Giuliani, F., 1999. Control of binder content in bituminous mixes by means of an automatic apparatus, in: Transcom'99. Zilina, Italy.
22. State of California – Business, transportation and housing agency / California test 310, 2000. Method of test for determination of asphalt and moisture contents of bituminous mixtures by hot solvent extraction.
23. Texas DOT Tex-210-F, 2008. Test Procedure for determining asphalt content of bituminous mixtures by extraction.
24. EN 12697-39, 2012. Bituminous mixtures - Test methods for hot mix asphalt - Part 39: Binder content by ignition.
25. Ma Tao, Zhang Daoyi, Huang Xiaoming (2008). Influential factors and improvement of extraction and recovery of SBS modified asphalt. Journal of Southeast university (natural science edition) 38(5):811-815.
26. Burr, B.L., Davidson, R.R., Glover, C.J., and Bullin, J.A (1990). Solvent Removal from Asphalt. In Transportation Research Record: Journal of the Transportation Research Board, No. 1269. Transportation Research Board of the National Academies, Washington, DC, pp. 1-8.
27. Liu Zhihui (2012). Recycling asphalt pavement recovery experiment and regeneration technology. Master's Thesis. Chongqing Jiaotong University.
28. Hu Xudong (2003). The research on recycling and regeneration of the older asphalt pavement. Master's Thesis. Changsha University of Science & Technology.

Global Journal of Researches in Engineering: E
Civil And Structural Engineering
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

An Approach to Determine the Initial Shear Modulus of Clean Sandy Soils

By Mehmet I. Onur, Seyfettin U. Umu, Volkan Okur & Mustafa Tuncan

Anadolu University

Abstract- This study presents new empirical equations to estimate the initial shear modulus of clean sands under low strains by using soft computing methods. A series of resonant column tests were conducted on clean sand specimens. The effect of various factors, such as effective stress, saturation degree, void ratio and shear strain levels, were considered by using fuzzy expert systems, neural networks and regression analysis. A new empirical equation was developed to determine the initial shear modulus of clean sand samples and compared with the existing empirical relationships in the literature. Success of the new equation was increased by considering boundary conditions at the shear strain ranges given by the ASTM standards for the resonant column test. It was found that the new formulation has a high level accuracy for determining the initial shear modulus of Toyoura sand samples. And also it can be used for clean sandy soils having similar properties. It was suggested that new approaches can be developed by using soft computing techniques to identify the dynamic shear modulus of sandy soils.

Keywords: toyoura sand; resonant column test; shear modulus; dynamic loading, empirical equation.

GJRE-E Classification: FOR Code: 090599

Strictly as per the compliance and regulations of :

An Approach to Determine the Initial Shear Modulus of Clean Sandy Soils

Mehmet I. Onur [α], Seyfettin U. Umu [σ], Volkan Okur [ρ] & Mustafa Tuncan [ω]

Abstract- This study presents new empirical equations to estimate the initial shear modulus of clean sands under low strains by using soft computing methods. A series of resonant column tests were conducted on clean sand specimens. The effect of various factors, such as effective stress, saturation degree, void ratio and shear strain levels, were considered by using fuzzy expert systems, neural networks and regression analysis. A new empirical equation was developed to determine the initial shear modulus of clean sand samples and compared with the existing empirical relationships in the literature. Success of the new equation was increased by considering boundary conditions at the shear strain ranges given by the ASTM standards for the resonant column test. It was found that the new formulation has a high level accuracy for determining the initial shear modulus of Toyoura sand samples. And also it can be used for clean sandy soils having similar properties. It was suggested that new approaches can be developed by using soft computing techniques to identify the dynamic shear modulus of sandy soils.

Keywords: toyoura sand; resonant column test; shear modulus; dynamic loading, empirical equation.

I. Introduction

The maximum shear modulus, G_{max}($\gamma<5\times10^{-4}$%),provides information about the soil strength and rigidity in cyclic loading. Shear modulus of various soils at very small levels of strains can be called maximum shear modulus, initial shear modulus, or low-amplitude shear modulus, and denoted by G_{max} or G_0 (Ishihara, 2003).Shear modulus is generally determined by field tests or by laboratory tests, such asresonant column (RC), dynamic triaxialand bender element methods (Youn et al. 2008). The shear modulus can be measured at strain levels between $\%10^{-4}$ and 10^{-1} by performing resonant column test.

There are many equation and various experimental relationships proposed for the determination of the initial shear modulus of sandy soils in the literature. The most popular empirical equation based on laboratory experiments is presented by Hardin and Drnevich(1972a-b). Although these tests provide adequate results, preparing high quality undisturbed samples and simulating field conditions are the main problems in the laboratory testing. Altun and Goktepe(2006)emphasized the deficiencies of the laboratory test on the cyclic response of soils, such as reconstitution of non-cohesive samples and the unidentified geological stress history affect. Cyclic testing to simulate the real cyclic responseis also expensive and requires much time. Alternatively, the dynamic properties of soils can be determined by using soft computing techniques, such as artificial intelligence based on field or laboratory data(Hasal and Iyisan, 2014). However, artificial intelligence (AI) cannot fully simulate the complex response of the systems; the use of AI technologies, such as fuzzy logic, neural networks, evolutionary computations, and expert systems, provides partial simulations. In addition, using these methods provides effective feasibility analysis, early decisions and so on(Akbulut et. al. 2004).

Engineers generally prefer AI applications due to the creation of non-linear mappings between the input and output variables in optimum time and cost. As a result, many researchers began to use AI applications to evaluate dynamic soil parameters. Cabalar et al. (2012), Heider et.al. (2014), and Umu et.al.(2016)compared different AI models to predict the shear modulus and damping ratio of sandy mixtures. Shanpo et.al.(2012) and Ghorbani et.al(2012)createda database based on laboratory tests of sand mixtures to determine the dynamic response and liquefaction potential. Shahnazari et al.(2010) generalized formulations to simulate the strain–stress curves and the modeled dynamic stress–strain behavior of sands by using AI-based genetic programming. It can be concluded from many published studies that AI models well describe the dynamic characteristics of soils.

Many previous study showed that the dynamic behavior of sandy soils are affected by various factors, such as water content, void ratio (relative density), confining stress, particle shape and soil fabric(Salgado et al. 2000). In this study, to determine the dynamic behavior using AI-based genetic applications, a series of RC tests were conducted on reconstituted sand samples. Clean sand samples were prepared under fully saturated, partially saturated and dry conditions. The tests were conducted under undrained and stress-controlled conditions. The input variable data (void ratio, effective stress, shear strain, and saturation degree) were obtained from the tests and used by soft computing techniques to evaluate the output parameters (resonant frequency and shear modulus). A

Author α ω: Dept. of Civil Engineering, Anadolu University, Eskisehir, Turkey. e-mail: mionur@anadolu.edu.tr
Author σ: Transportation Vocational School, Anadolu University, Eskisehir, Turkey.
Author ρ: Dept. of Civil Engineering, Eskisehir Osmangazi University, Eskisehir, Turkey.

new empirical equation was developed and compared with the existing equations in the literature according to its accuracy level.

II. Experimental Study

A resonant column (RC) test device was used to determine the cyclic response of the reconstituted sand samples. The resonant column method is used to determine the dynamic properties of soils, concrete, and rocks with respect to the theory of wave propagation. The details of the resonant column tests are explained by Drnevich(1985) and in the Standard of ASTM D 4015-87(2000).

The RC test configuration used in this study is a fixed-free system, in which the sample is fixed at the bottom and is free to rotate at the top. The wave velocity and the degree of material damping can be determined by measuring the motion of the free end. Then, the shear modulus is derived from the velocity and the density of the sample. The bottom of the specimen is fixed to the base of the apparatus. Sinusoidal torsional excitation is applied to the top of the specimen by an electric motor system. A torsional harmonic load with a constant amplitude is applied over a range of frequencies, and the response curve (strain amplitude) is calculated. The output angular acceleration at the top of the sample is recorded by an accelerometer. The frequency of the cyclic torque is gradually changed until the first resonance of torsional vibration is obtained. The shear wave velocity is obtained from the first-mode resonant frequency. The initial shear modulus for shear strain ranging from 0.001-0.009% to 0.01-0.023% is then calculated using the shear wave velocity and the density of the sample.

Standard uniform Toyoura sand was chosen for the study to allow for easy comparison with the literature. Index and shear strength parameters of Toyoura sand is taken from different studies in the literature. Some basic characteristics are given in Table 1. The test specimens were solid cylindrical samples with an approximate diameter of 50 mm and a height of 130-135 mm. The initial relative density and saturation degree are the most important factors regarding the cyclic behavior of sandy soils. Therefore, the test samples were prepared at different initial void ratios and saturation degrees. Two methods of sample preparation, dry deposition (for dry samples) and moist placement (for partially saturated and fully saturated samples), were preferred because of time consuming by these methods. The experimental details of the study are shown in Table 2.

Table 1: Basic characteristics of Toyoura sand

Material	Toyoura Sand
D_{50} (mm)	0.26
D_{10} (mm)	0.21
C_u	1.33
C_c	0.98
G_s	2.653
ρ_{maks}(Mg/m^3)	1.34
ρ_{min}(Mg/m^3)	1.64
e_{maks}	0.97
e_{min}	0.597
c (kPa)	4
ϕ	39°

D_{10} = diameter corresponding 10% finer, D_{50} = corresponding 50%, finer, C_u = coefficient ofuniformity, C_c = coefficient of curvature, ρ: bulk density, e_{max}, e_{min}= maximum and minimum void ratio, c=cohesion, ϕ=angle of shear strength;

Table 2: Details of the experiments performed in the study

	(e_{int})	σ_o'(kPa)	%Dr	H_{sample}(mm)	R_{sample}(mm)	%S_r	%γ
Max.	0.7959	348.8	47.66	135	50	99.98	0.04
Min.	06166	25.8	94.85	130	50	0	0.001

III. Model Study

Many real-world problems cannot be solved by using conventional approaches because of an inadequate amount of time. Therefore, various soft computing techniques using predictive modeling are preferred for such problems. In particular, fuzzy logic and neural networks are the most popular and widely used techniques because of their benefits in modeling.

a) Generation of the fuzzy expert system (FES)

Fuzzy modeling offers control mechanisms for problems that have uncertainties and building solution steps. A multi-level decision-making mechanism provides an expert system with a knowledge base, an inference mechanism, and a user interface, although with a varying number of elements (Zadeh, 1994, Jang et. al. 1997). In this study, Math Works MATLAB software was used for fuzzy membership functions and rules. The

structure of the fuzzy expert system was created by using the MATLAB Fuzzy Logic Toolbox for all test results. In this study, the input variables were void ratio, effective stress, shear strain amplitude, saturation degree, and the output variables were resonant frequency and maximum shear modulus. The next step was definition of the fuzzy rules to perform fuzzy reasoning. The fuzzy rules were constructed on an "if-then" structure, in which they provided the conditional statements that comprised the fuzzy logic. The "if-then"statements are defined as follows:

$$R: \textbf{IF}\ \text{value}\ x=A_i\ \text{and}\ y=B_i\ \text{and}\ z=C_i \textbf{THEN}\ n = D_i\ (i = 1,2,....,k) \quad (1)$$

where x, y, and z are the input variables, and n is the output parameter described by fuzzy subsets. Two hundred and ten rules were written for the shear modulus and the resonant frequency. The abbreviations of the membership functions are given in Table 3.

Table 3: Abbreviations and meanings of the membership functions (FES)

Linguistic Rule	Abbreviations
Extremely High	VR7, EP6, G8, V6, FR7
Very High	VR6, EP5, SS5, G7, V5, FR6
High	VR5, EP4, SS4, G6, V4, FR5
Medium High	G5
Medium	VR4, SS3, FR4
Medium Low	G4
Low	VR3, EP3, SS2, G3, V3, FR3
Very Low	VR2, EP2, SS1, G2, V2, FR2
Extremely Low	VR1, EP1, G1, V1, FR1

The output parameters related with each input variable were evaluated by using the test results. The percentages of the weighted output parameters were calculated and defined in the form of "if-then" statements. A total of 516 rules for the maximum shear modulus, 492 rules for the resonant frequency were defined with this way.

The rules were defined according to the MATLAB Fuzzy Logic Toolbox to construct the FES variables. Two built-in AND methods, min (minimum) and prod (product), and two built-in OR methods, max (maximum) and probor (probabilistic OR method),were used to evaluate the values of the resonant frequency and the maximum shear modulus. The best recall performances of the FES indicate that the system has an acceptable performance. The determination value (R^2) for the resonance frequency and the maximum shear modulus are shown in Fig. 2(a) and Fig. 2(b), respectively.

b) Generation of the Artificial Neural Networks (ANNs)

An artificial neural network is a soft computing technique that provides information processing by using the simulation of nerve cells and networks(Fahman, 1988). In this study, a supervised learning network using feed forward back propagation was performed. Alyuda NeuroIntelligence (ANI) software was used to design the structure of the neural network, and the network was compared with the other structures created by MATLAB. Various results were observed by selecting different layers and neurons. The dataset was formed by randomly separation method into training and validation. Hence, 226 tests were used for validation and 485 tests were used for training and is given in Fig. 1.

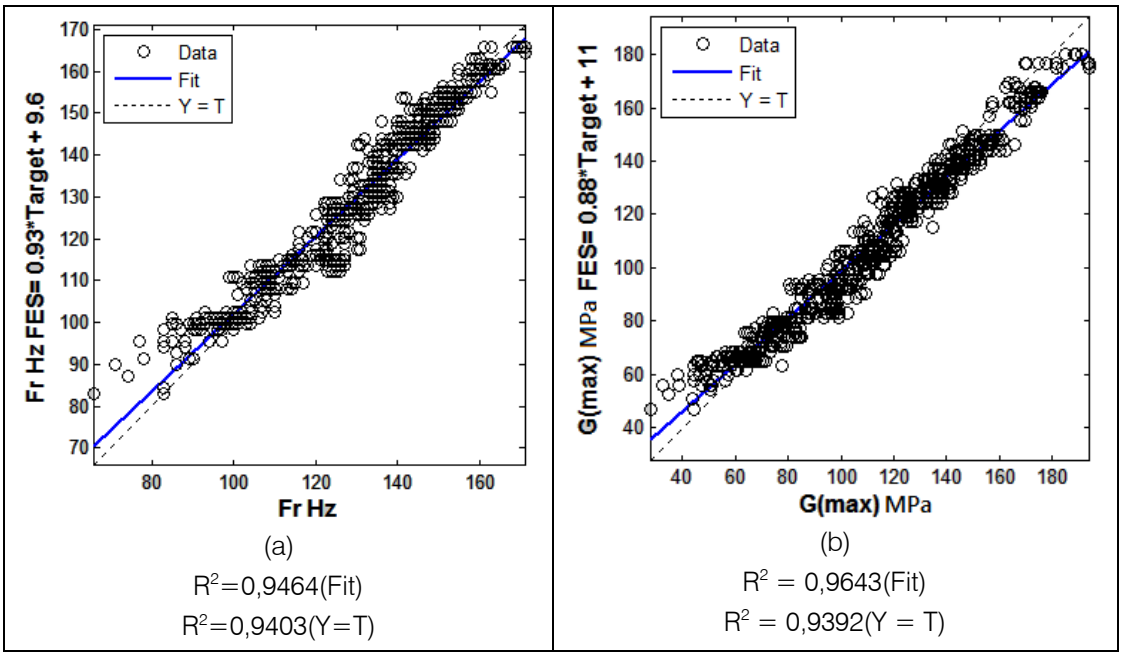


Fig. 1: Inference results: (a) resonant frequency and (b) maximum shear modulus

The Levenberg-Marquardt (LM) algorithm was used to train all the networks. LM was used because the algorithm is known as the optimum training algorithm and gives a virtual standard in nonlinear optimization. LM is a pseudo-second-order method, i.e., it does not only work with function evaluations and gradient information but also it estimates the Hessian matrix using the sum of the outer products of the gradients. LM quickly minimizes the error function and uses the Jacobian matrix instead of the Hessian matrix. The parameter, μ, is the Marquardt parameter, used in the calculation of the Hessian matrix (Hagan and Menhaj 1994).

$$H(n) = J^T(n)J(n) + \mu I \quad (2)$$

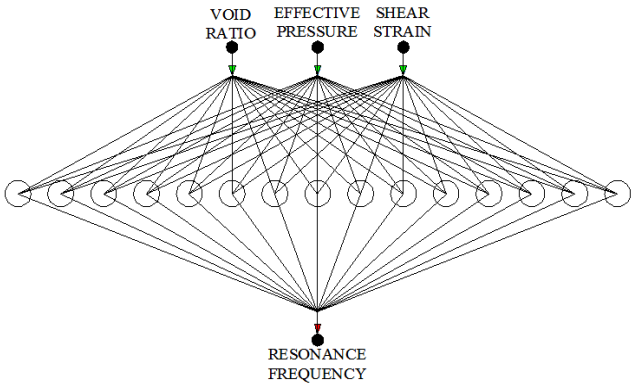
The weights and bias values are updated as follows:

$$w(n+1) = w(n) - (H)^{-1}J^T(n)e(n) \quad (3)$$

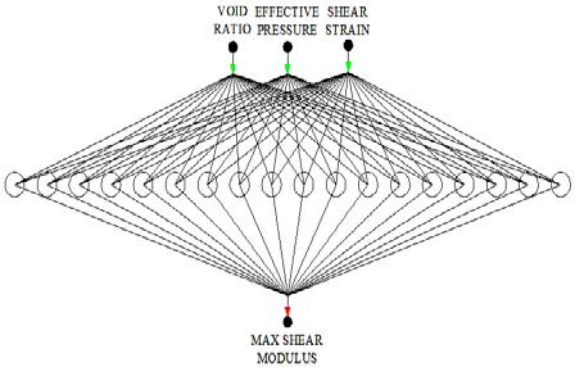
The data for the input and output parameters are given in Table 4. An exhaustive search option in the ANI was used to choose the input variables. The optimal NN architecture was found as3-15-1 NN architecture for resonant frequencyand3-18-1 NN architecture for shear modulus. The NN architectures created by using Matlab NN are shown in Fig.2.

Table 4: Input and output parameter data

Total Sample:711	e_{int}	σ_o'(kPa)	γ(%)	S_r(%)	f_r	G_{max} (MPa)	V_s (m/sn)
Column Type	Input	Input	Input	Input	Output	Output	Output
Format	Numerical	Numerical	Numerical	Numerical	Numerical	Numerical	Numerical
Scaling Range	[-1…1]	[-1…1]	[-1…1]	[-1…1]	[0…1]	[0…1]	[0…1]
Min	0.6166	25.8	0.001	0	66	27.97	120.34
Max	0.7959	348.8	0.04	99.98	171	193.92	343.83
Mean	0.733718	150.83884	0.005447	60.76166	130.734177	112.976414	248.98495
Std. Deviation	0.046822	75.95824	0.006556	46.54837	21.815257	35.981497	45.01604



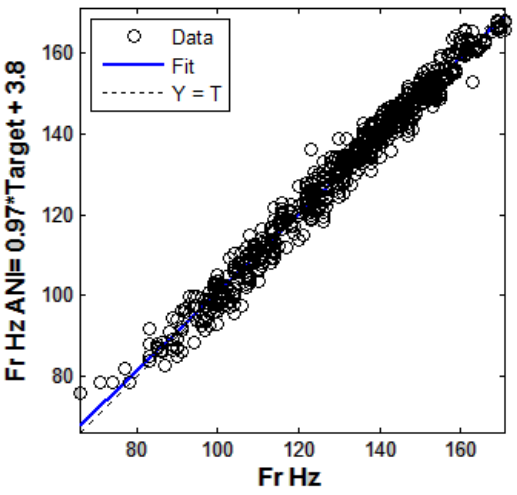
Architecture Fitness R^2 = 0.98[3-15-1]



Architecture Fitness R^2 = 0.99[3-18-1]

Fig. 2: The network structure for the considered dynamic properties

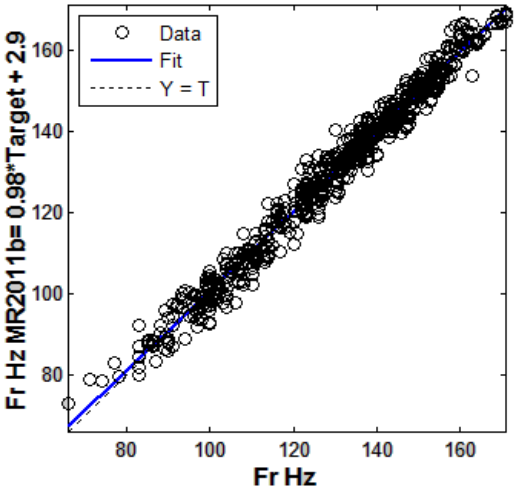
The same input variables were used and the linearity of the relationship between the parameters for the single-layer structure was found to be acceptable. The coefficients of determination value (R^2) (Y=T) are 0.9785 and 0.9787for the ANI predictions of resonance frequency and maximum shear modulus, respectively, which implies a significant value for R^2 and hence a good performance for the whole model. The results are presented in Fig.3.



Resonant Frequency ANI Results

R^2 = 0.9793(Fit)

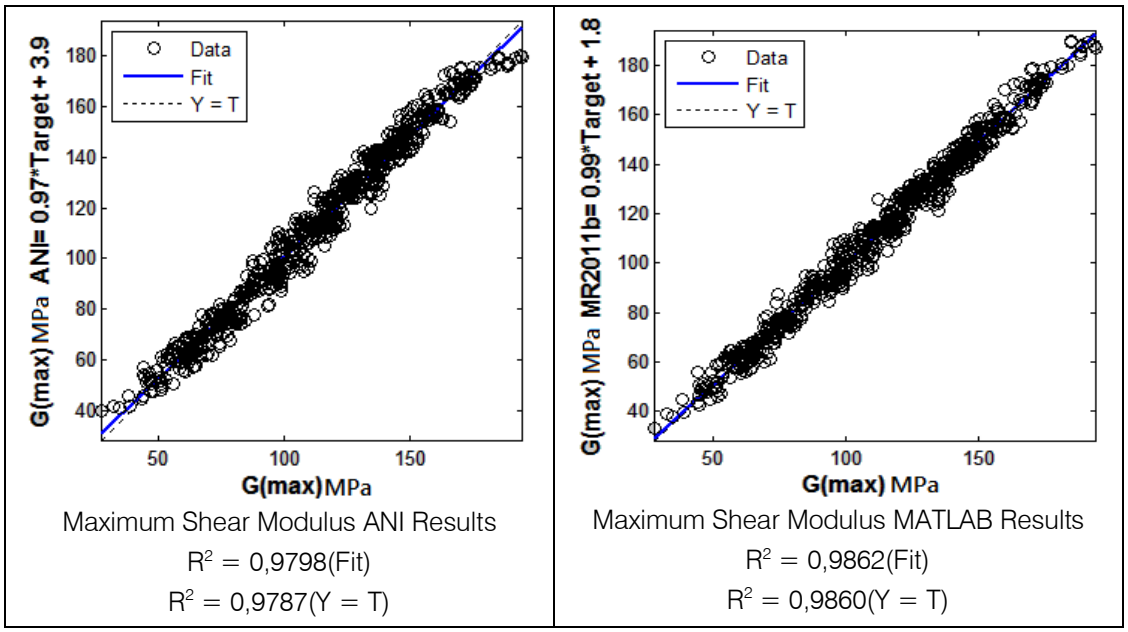
R^2 = 0.9785(Y = T)



Resonant Frequency MATLAB Results

R^2 = 0.9793(Fit)

R^2 = 0.9788(Y = T)



Maximum Shear Modulus ANI Results
R^2 = 0,9798(Fit)
R^2 = 0,9787(Y = T)

Maximum Shear Modulus MATLAB Results
R^2 = 0,9862(Fit)
R^2 = 0,9860(Y = T)

Fig. 3: Neural network results for the considered dynamic properties

c) Generation of the Empirical Equation

The shear strain level is an important factor on the shear modulus. It is already known that the resonant column experiments are capable by achieving shear strain within an amplitude range of 10^{-6}-10^{-3}(Ishihara 2003).In any type of laboratory test, the shear modulus of cohesionless soils at low strain is measured under different effective confining stresses (σ'_0) for various conditions presented by different void ratios (e). In the early works by Hardin and Richart(1972a-b), the effect of void ratio is found to be expressed by a function F(e):

$$F(e) = \frac{(2{,}17-e)^2}{1+e} \text{ or } F(e) = \frac{(2{,}97-e)^2}{1+e} \quad (4)$$

Thus, it is appropriate to divide the measured shear modulus (G_{max}) by the function F(e) and plot this ratio against the effective confining stress applied in the test (Kokusho 1987). The amplitude of the shear strain is obtained by converting the axial strain in the triaxial test through the following relationship:

$$\gamma_a = (1+\nu)\varepsilon_a \quad (5)$$

A number of similar formulas are proposed for various sand types, as shown in Table 5; however, most of these formulas can be expressed in the general form of Eq.(5).(Kokusho1987)For a sufficient small shear strain of $\gamma_a = 10^{-5}$, a typical formula is specified as Eq.(6):

$$G_0 = AF(e)(\sigma'_0)^n \quad (6)$$

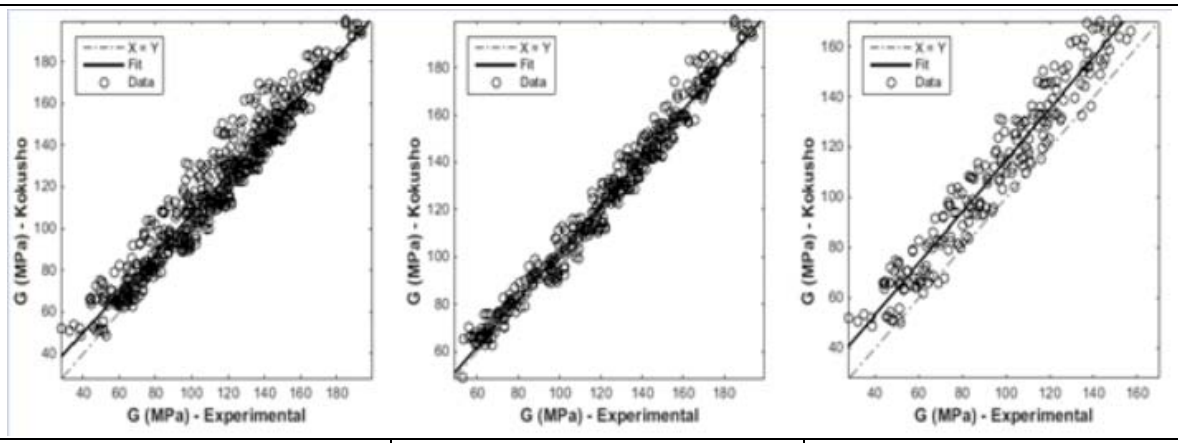
$$G_0 = 8400\frac{(2{,}17-e)^2}{1+e}(\sigma'_0)^{0.5} \quad (7)$$

Table 5: Selected empirical relationships for various sand types

References	A	F(e)	n	Soil Material	Test Method
Hardin-Richart (1963)	7000 3300	$(2{,}17-e)^2/(1+e)$ $(2{,}97-e)^2/(1+e)$	0,5 0,5	Round Grained Ottowa Sand Angular Grained Crashed Quartz	Resonant Column
Shibata-Soelarno (1975)	42000	$(0{,}67-e)/(1+e)$	0,5	Three types of clean sand	Ultrasonic Pulse
Iwasaki et.al. (1978)	9000	$(2{,}17-e)^2/(1+e)$	0,38	Eleven types of clean sand	Resonant Column
Kokusho (1980)	8400	$(2{,}17-e)^2/(1+e)$	0,5	Toyoura Sand	Cyclic Triaxial
Yu-Richart (1984)	7000	$(2{,}17-e)^2/(1+e)$	0,5	Three types of clean sand	Resonant Column
G_0:kPa; σ'_0:kPa; e: void ratio					

In this study, the experimental results were compared with the existing empirical relationships for the initial shear modulus obtained by performing various test devices for several types of sands at the shear strain of 10^{-5}. All the results ($0.001 \leq \gamma\% \leq 0.04$) of the empirical relationships were recomputed using the void

ratio and the effective stress from the test results. The empirical relationship for the shear modulus given by Kokusho(1987)was found more appropriate for the values obtained from the test results in the range of the shear strain amplitude. The comparison between experimental results and literatureis shown in Fig.4. The experimental test results were found to be in excellent agreement with the literature at a small shear strain amplitude.



$R^2 = 0.9111$ (x = y) $0.001 \leq \gamma\% \leq 0.04$	$R^2 = 0.9742$ (x = y) $0.001 \leq \gamma\% \leq 0.005$	$R^2 = 0.7452$ (x = y) $0.005 < \gamma\% \leq 0.04$

Fig. 4: Suitability of the experimental results and the Kokusho equation

A new empirical relationship for the initial shear modulus was derived from the experimental studies at different shear strain levels by considering test data, the fuzzy expert system and the neural network results. Dynamic responses of soils can be determined atstrain levels between 10^{-6} and 10^{-2} by different test methods. But, decrease in shear modulus is observedfrom %0,005 strain levels to %0.0001 strain levels in the previous studies. Accuracy of the new equation was increased by considering boundary conditions at the shear strain ranges given by the ASTM standards for the resonant column test. Therefore, a new relationship to determine the initial shear modulus was divided into two parts given by Eq.(8) and Eq.(9).

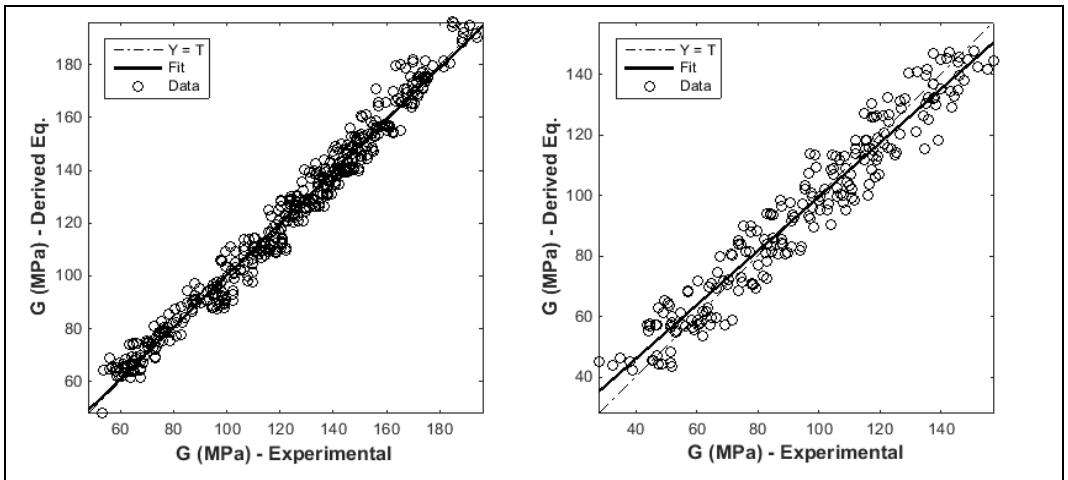
In the range of $0.001 \leq \gamma\% \leq 0.005$, the equation is given below,

$$G_0 = 8254 \frac{(2{,}17-e)^2}{1+e} (\sigma_0')^{0{,}49} \quad (8)$$

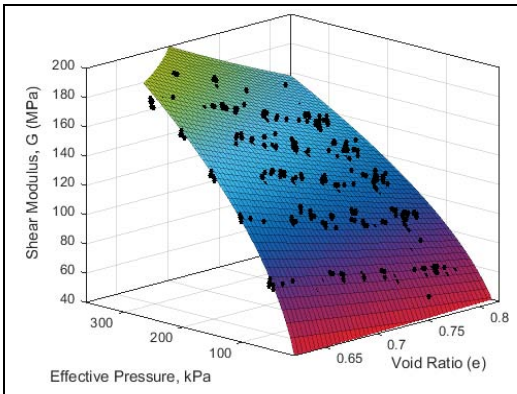
In the range of $0.005 < \gamma\% \leq 0.04$, the equation is given below,

$$G_0 = 7294 \frac{(2{,}17-e)^2}{1+e} (\sigma_0')^{0{,}49} \quad (9)$$

The coefficients of determination value (R^2) (Y=T) are 0.9767 and 0.9362, respectively. Using these two equations for the prediction of the initial shear modulus, which implies a significant value for R^2 and indicates good performance for the whole model. The suitability of the derived empirical relationship according to the variation of the shear strain amplitude is shown in Fig.5.



$R^2 = 0.9773$ (x = y) $0.001 \leq \gamma\% \leq 0.005$	$R^2 = 0.921$ (x = y) $0.005 < \gamma\% \leq 0.04$



$R^2 = 0.9767$ (Fit)	$R^2 = 0.9327$ (x = y)
$0.001 \leq \gamma\% \leq 0.005$	$0.005 < \gamma\% \leq 0.04$

Fig. 5: Suitability of the experimental results to the new empirical equation

IV. Conclusions

A series of RC tests was conducted on clean sand samples to create a new approach by using AI techniques for the prediction of the dynamic characteristics of soils. MATLAB software was used to perform data analysis and modeling. Test results were analyzed by considering saturation degree, effective stress and cyclic strain. First, two inference systems were performed to predict the maximum shear modulus and the database was created by using the experimental study. Compared with the test results, both inference system models were found to be quite suitable. Subsequently, new empirical relationships in the prediction of the dynamic characteristics of Toyoura sands were derived. New equation is divided in two groups by considering boundary conditions at the shear strain ranges given by the ASTM standards. Therefore, new formulation has a high level accuracy for determining the initial shear modulus of Toyoura sand samples. The equations showed acceptable results that were the analogous to those of the soft computing techniques. These results revealed that both methods can be used for practical purposes to solve complex real life problems. This study encourages further work to explore other inference systems for the estimation and generation of data from experimental studies.

V. Acknowledgements

This study was supported by Anadolu University Scientific Research Projects Commission under the grant no: 09-02-05 and Eskisehir Osmangazi University Research Fund with Project Number 2014-631

References Références Referencias

1. Akbulut, S.Hasiloglu, A.S.Pamukcu, S. (2004) Data generation for shear modulus and damping ratio in reinforced sands using adaptive neuro-fuzzy inference system, Soil Dynamics and Earthquake Engineering, 24, 805-814.
2. Altun, S. and Göktepe, A.B. (2006) Dependence of dynamic shear modulus of uniform sands on stress level and density, Civil Engineering and Environmental Systems, 23(2), 101-116.
3. ASTM D4015-87, (2000) Standard Test Methods for Modulus and Damping of Soils by Resonant-Column Method.
4. Cabalar, A.F., Cevik A., Gokceoglu C. (2012) Some applications of Adaptive Neuro-Fuzzy Inference System (ANFIS) in geotechnical engineering, Computers and Geotechnics, 40,14-33.
5. Drnevich, V.P. (1985) Recent development in resonant column testing, Proceedings, Richart Commemorative Lectures, ASCE annual meeting, Detroit, MI.
6. Fahlman, S.E.(1988) Faster-Learning variations on back-propagation: an empirical study, Proceedings Connectionist models summer school, Morgan-Kaufmann, CA.
7. Ghorbani, A., Jafarian Y. and Maghsoudi, M.S. (2012) Estimating shear wave velocity of soil deposits using polynomial neural networks: Application to liquefaction. Computers &Geosciences, 44, 86-94.
8. Groholski, D.R. and Hashash, Y.M.A. (2013)Development of an inverse analysis framework for extracting dynamic soil behavior and pore pressure response from down hole array measurements, Int. J. Numerical Analysis Methods in Geomechanics., 37, 1867-1890.
9. Hagan, M.T. and Menhaj, M.B.(1994) Training feedforward networks with the Marquardt algorithm, IEEE Transactions on Neural Networks, 5(6), 989-993.
10. Hardin, B.O. and Drnevich, V.P. (1972a-b) Shear modulus and damping of soils: measurement and parameters effects (a), design equation and curves

(b), Journal of the Soil Mechanics and Foundations Division, ASCE, 98: 603-624(a), 667-692(b).
11. Hasal, M.E., and Iyisan, R. (2014) A numerical study on comparison of 1D and 2D seismic responses of a basin in Turkey, American Journal of Civil Engineering, 2(5), 123-133.
12. Heider, Y., Avci, O., Markert, B., Ehlers, W. (2014) The dynamic response of fluid-saturated porous materials with application to seismically induced soil liquefaction, Soil Dynamics and Earthquake Engineering, 63, 120-137.
13. Ishihara, K. (2003)Soil behavior in Earthquake Geotechnics, Clarendon Press, Oxford.
14. Jang, J.S.R. Sun, C. T. Mizutani, E. (1997) Neuro-Fuzzy and soft computing. Prentice Hall, Upper Saddle River NJ.
15. Kokusho T., (1987) In-situ dynamic soil properties and their evaluations, Proc. 8th Asian Regional Conf. on SMFE.
16. Salgado, R. Bandlini, P. and Karim A. (2000) Shear strength and stiffness of silty sand, Journal of Geotechnical and Geoenvironmental Engineering, 126(5), 451-462.
17. Shahnazari, H. Dehnavi, Y. and Hossein, A.A. (2010) Numerical modeling of stress–strain behavior of sand under cyclic loading, Engineering Geology, 116, 53-72.
18. Shanpo, J. Youqing, Z. and Chensong, Z. (2012) Numerical solution to identification problems of material parameters in geotechnical engineering, Procedia Engineering, 28, 61-65.
19. Umu, S.U., Onur, M.I., Okur, V., Tuncan, M., Tuncan, A., (2016) Reliability evaluation of dynamic characteristics of clean sand soils based on soft computing methods", Arab J Sci Eng, 41(4), 1363-1373.
20. Youn, J. Choo, Y.and Kim, D. (2008) Measurement of small-strain shear modulus Gmax of dry and saturated sands by bender element, resonant column and torsional shear tests, Canadian Geotechnical Journal, 45,1426-1438.
21. Zadeh, L.A. (1994) Fuzzy logic, neural networks and soft computing, Comm. ACM, 37(3), 77-84.

Global Journals Inc. (US) Guidelines Handbook 2017

www.GlobalJournals.org

FELLOWS

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (FARSE)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSE" title to individuals. The 'FARSE' title is accorded to a selected professional after the approval of the Editor-in-Chief /Editorial Board Members/Dean.

- The "FARSE" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSE or William Walldroff, M.S., FARSE.

FARSE accrediting is an honor. It authenticates your research activities. After recognition as FARSE, you can add 'FARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSE designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSE title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSE can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSE, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

The FARSE will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSE member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSE members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSE member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSE is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSE can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSE member can decide its price and we can help in making the right decision.

The FARSE member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (MARSE)

The 'MARSE ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The "MARSE" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSE or William Walldroff, M.S., MARSE.

MARSE accrediting is an honor. It authenticates your research activities. After becoming MARSE, you can add 'MARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSE designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSE, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSE member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

AUXILIARY MEMBERSHIPS

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

You must strictly follow above Author Guidelines before submitting your paper or else we will not at all be responsible for any corrections in future in any of the way.

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

Global Journal of Researches in Engineering

Visit us on the Web at www.GlobalJournals.org | www.EngineeringResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9755861