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November 5-6, 2016 / The Howard Civil Service International House , Taipei, Taiwan

Taiwan Society of Tribology Technology

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台灣磨潤科技學會

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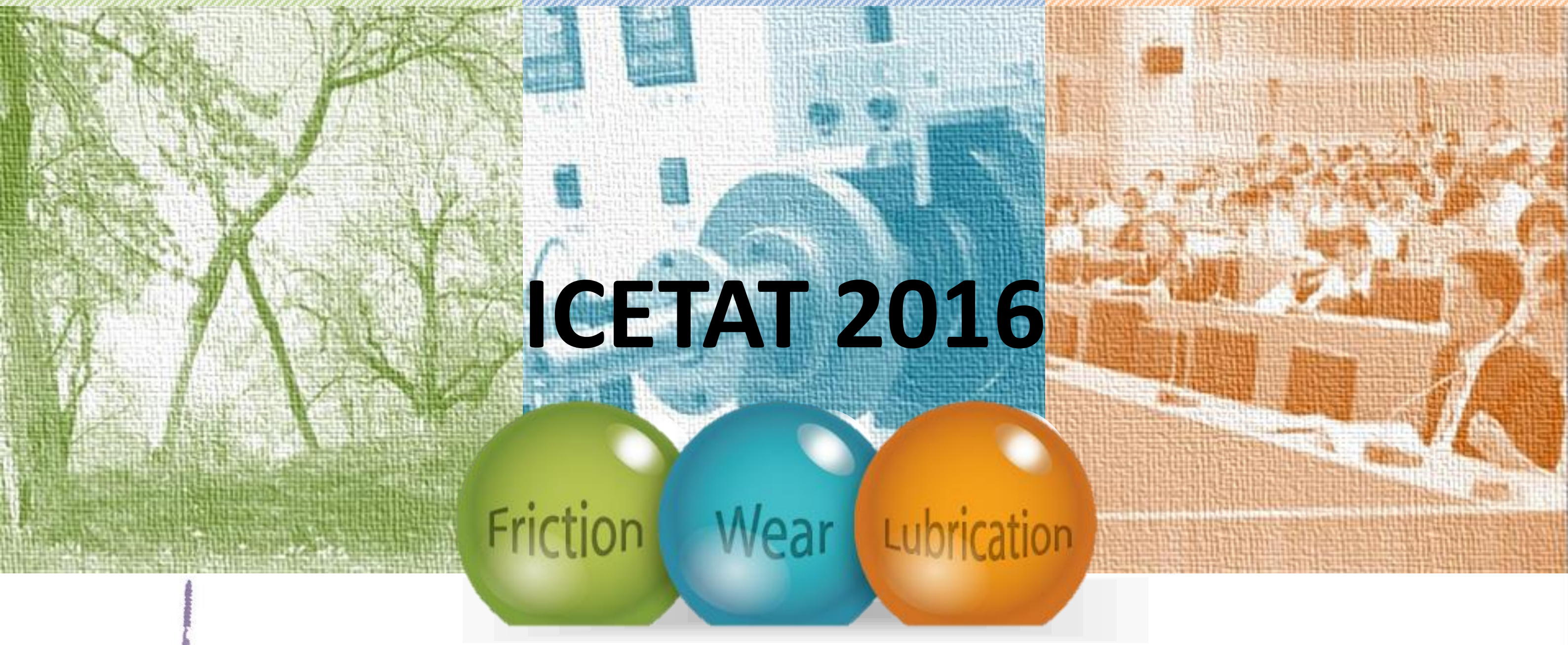
ICETAT 2016



2016 International Conference on Engineering Tribology and Applied Technology

Organized by

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2016 International Conference on Engineering Tribology and Applied Technology

PBII&D

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Message From - H Peter Jost

International Tribology Council

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June 2016

MESSAGE FROM

H PETER JOST

for the 2016 International Conference on Engineering Tribology and Applied Technology - ICETAT2016

Taiwan – 4 - 6th November 2016

Greetings to the Chairman and Members of the Organising Committee and all participants of ICETAT2016.

In the early days, tribology was regarded largely as lubrication engineering. Since then, much in line with the development of the rest of our world, tribology has also developed. It covers not only the lubrication - now approximately 20% of tribology - and very important it is – but also to other friction related areas, multi-disciplinary and defined as *the physical science based generic technology of friction (and wear)*.

As far as industry is concerned, the aim of the work of tribologists is the improvement of productivity, reduction of the use of energy and materials, which are of not unlimited quantities, all ultimately leading to better security and enjoyment of life for all of us.

I suggest to you, the coming generation of wealth creators, that the benefits of tribology cannot be ignored and should be the aim of all of you – for your benefit and for the benefit of your respective countries

Wishing you success for this important ICETAT2016 Conference.

H Peter Jost
President

Forward

To plant a seed, and see it sprout and grow, what an indescribable joy it is to the sower!

It has been forty years since my articles: "On tribology education" appeared in Taiwan's Economics Daily News on May 5th, 1975, and "The resonance of tribology education" appeared in Taiwan's Central Monthly Magazine on August 5th, 1975. As the first person in Taiwan to translate the word "tribology", to see tribology grew from not being widely recognized--the general understanding then was limited to the need to lubricate mechanical devices for friction and wear prevention--to being so widely known and highly valued in so many areas today, my heart is filled with boundless honor and delight!

I would like to welcome all of you, ladies and gentlemen, distinguished participants of the 2016 International Conference on Engineering Tribology and Applied Technology (ICETAT 2016), and to thank all the leaders and colleagues in the organizing team. Thank you for your hard work! With such abundant and excellent research results, ICETAT 2016 will surely achieve the goal of scholarly exchange with great success. Best wishes to all of you!

Ke-Yang Li

Respectfully yours,
Ke-Yang Li
The first person to translate the term "Tribology" into Chinese in Taiwan
4th, November, 2016

Welcome Messages

This is my best opportunity to express our warm welcome to all of your participation in the 2016 International Conference on Engineering Tribology and Applied Technology (ICETAT2016). The Taiwan Society of Tribology Technology (TSTT) would like to invite you enjoying the scenery of beautiful capital city - Taipei. This is the 2016 international tribology and applied technology conference held in Taiwan. It has great meaning for us. The objective of this conference is to facilitate close dialogues among experts on issues relating to research and technological development on engineering tribology and other applied technologies.

More than two hundred researchers and contributors from the world submitted about 150 papers. More than 200 registered participants will take part in the work of the ICEAT2016 Conference. The papers accepted for publication have considered containing new developed data or technologies that deserve to be presented in ICETAT2016. Authors from Australia, Belarus, China, Finland, Germany, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, New Zealand, Netherlands, Qatar, Thailand, Turkey, United States of American United Kingdom, and Russia are included in ICETAT2016 proving our international orientation.

One hundred and fifty papers presented in the following sessions: Biotribology, Coating, Dynamics and vibrations, Examination and test, Friction, Industrial application, Lubrication, Machine element, Manufacture and surface, Mechanism and manufacture, Micro tribology, Surface and contact, and Wear, etc. We would like to appreciate the authors for submitting their excellent research works to the conference and contributing to the quality of final program. We also acknowledge our profound gratitude to the reviewers for their time, efforts and comments in evaluating the papers, and the distinguished plenary and invited speakers for accepting our invitation. I wish that all of you have a nice stay and wonderful vacation in Taiwan. Good luck with my best regards.

Finally, we will express our sincere gratitude to Ministry of Science and Technology (Taiwan), National Formosa University, National Taiwan Ocean University, TaTung University and Taiwan Society of Tribology Technology for their supports in organizing ICETAT2016 Conference.

Jeng-Haur Horng

Jeng-Haur Horng
Distinguished Professor, National Formosa University
President, Taiwan Society of Tribology Technology (TSTT)
Taipei, Taiwan
November, 2016

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Finite element modelling of the insole shoe orthotic for foot deformities

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ABSTRACT – A finite element models to (FEM) of the human foot, especially the experience of foot deformities such as pronation, Metatarsalgia, Flat Feet, Neuroma, Plantar Fasciitis, Arch Pain, and diabetes can be quickly developed and dealt into 3D solid .STL file using foot scan IQube 550. Solid abnormal human foot model consists of plantar facia and encapsulated soft tissue (indenter feet) with EVA rubber insole will be built into a 3D solid orthotic shoe insole in PowerSHAPE CAD 2015 then imported into the software ABAQUS 6:13 into 3D meshes FE analysis. Contact interactions that occur and be studied is between the indenter foot with shoe orthotic insole designed in various sizes. Abnormal foot contour obtained by the scanning process. Strategy curve-based surface modelling (CBS-modelling) was applied in this paper to obtain surface and solid models of shoe orthotic insole. 3D will be made some orthotic shoe insole to provide the size of the gap between the soles of the feet to the width of the insole designed. EVA rubber is used as an insole material. FEM analysis is used to obtain von misses stress from loading that varies on each insole with a predetermined gap width. The prediction results with FEM Abaqus 6:13. The result of the 3D solid with optimal insole shoe orthotic peak of $1{,}190\times10^{-3}$MPa von misses stress on the heel bone to the gap width of 1.75 mm.

Keywords: FEM, foot deformities, scanfoot, CAD, CAE, PowerShape 2015, Curve-base Surface modelling, insole shoe orthotic

1. INTRODUCTION

The abnormalities foot or foot deformities such as Pronation, Metatarsalgia, Flat Feet, Neuroma, Plantar Fasciitis, Arch Pain, and diabetes are closely related to the abnormal distribution of plantar pressure [2,3]. This causes the feet often become ill or have an insole syndrome resulting from the use of shoes that do not fit. Solutions to address this by creating a shoe orthotic insole that fits the contours of the foot problems. The process of making insole rapid, precise and accurate can use the method of reverse innovative design (RID) [1] where the leg disordered scanning with 3D foot scan to get a 3D mesh legs. In this method CAE application is absolutely necessary to obtain an optimal product designs prior to manufacturing process.

Computational modelling developed in Abaqus 6:13 CAE especially now able to enhance our knowledge of the biomechanics of the foot. FE analysis to that performed on shoe orthotic insole can predict the load distribution between the legs with designed insole. The finite element analysed enable efficient parametric evaluations to be made for the outcomes of the insole shape and material modifications, without needing to fabricate and test orthotics in a series of patient trial [4].

The research on the finite element analysis has contributed to understanding the behavior of foot biomechanics and performance supports [5-8]. Some researchers [5,6,7] have used it to study what orthotic effects thickness and stiffness have on the plantar soft tissue and plantar pressure distribution. But the design development orthotic shoe insole that fits the contours of the human foot is not currently done and is needed at all to improve the reliability of the design according the requirements in RID method (state of the art research).

The purpose of this study was to develop a 3D model of optimal orthotic insole shoe fit the contour of a human foot that is experiencing foot deformities. The FE model developed can be employed to predict the mechanical interaction between the foot as the indenter and different type of insole shoes. The different type of insole be set based on the difference gap between the wide leg with a wide insole. This research may help engineers and researchers in the field to get the orthotic shoe orthotic insole design optimal in people suffering from foot deformities.

2. METHOD

The most important aspect in the shoe insole is the insole design and quality of material insole. Insole foot will be the connector between the human and the legs.

The geometry of the finite element models are built up in this study was obtained from the 3D scan reconstruction process IQube 550 is capable of producing 3D meshes normal human leg and foot deformities that experienced at mid-fifties age and weight about 40 to 90 kg. The 3D meshes foot is taken by placing the foot on the screen so that the scanner will be obtained form the mesh leg (Figure 1).

Fig. 1. Stages of scanning the foot to obtain 3D meshes foot

To get the 3D surface and solid modelling strategy used orthotic insole shoe curve-based surface modelling (CBS-modeling). By using the features in PowerSHAPE 2015, it will produce curve shoe insole that will automatically fit the contours of the foot that are scanned. The curve is then quickly and easily can be raised into a 3D surface modeling with 3D surface and solid quality is good and ready to be imported into CAE (figure 2).

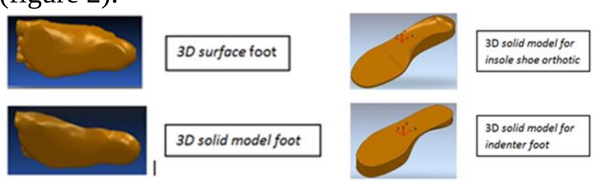

Fig.2. CBS-modeling insole shoe from PowerSHAPE 2015

Finite element models up from this study aimed at drawing 3 and can be categorized as a combination of 3D meshes feet (indenter) with EVA rubber (shoe orthotic insole) to be contacted in Abaqus 6:13 (Figure 3)

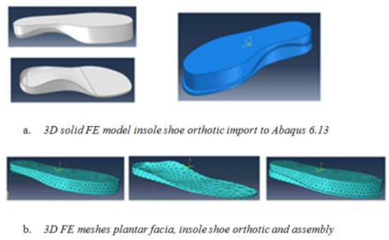

Fig 3. The 3D solid (a) and Mesh (b) FE insole shoe orthotic

From the figure 3a and 3b. that the model assembly between plantar facia, encapsulated soft tissue and EVA rubber insole shoe orthotic. The materials plantar facia were considered isotropic, homogeneous, and linear elastic (table 1) except for soft tissue with table 2[9] that were described by non linear elastic behaviour with material properties adopted from previous literature[10,11]. The hyper elastic material model was set to the encapsulate soft tissue. The hyper elastic material defined in Abaqus as Moonley-Rivlin was employed to represent the incompressible and nonlinearly elastic nature of bulk soft tissue[9].

Tabel 1. Material properties of parts used in the finite element model [10]

Component	Young's modulus (MPa)	Poisson's ratio	Element type
Bone	7300	0.3	Tetrahedral solid
Cartilage	1	0.4	Tetrahedral solid
Plantar fascia	350	0.4	Tetrahedral solid
Ligament	260	0.4	Tension-only Spar
Plate	17,000	0.1	Hexahedral solid

Tabel 2. The coefficients of the hyperelastic material used for telapak kaki

C_{10}	C_{01}	C_{20}	C_{11}	C_{02}	D_1	D_2
0.08556	−0.05841	0.03900	−0.02319	0.00851	3.65273	0.00000

The Young's modulus and Poisson ratio for plantar fascia are assigned each 350 MPa and 0.4. EVA insole material assigned to Rubber 400 with parameters Young's modulus and Poisson ratio respectively 0,04MPa and 0.49.

Measurement of plantar pressure distribution has been done to validate the FE model of the foot [10.12-15]. In this study, contact pressure distribution of the upper of shoe orthotic insole as plantar pressure and the peak value was extracted for the various Also insole models.

Results loading on the design variation orthotic shoe insole with a wide gap ranging from 2.0; 1.75; 1:50; 1:25; 1:00; 0.75; 0.5; and 0.25 mm are shown in this paper to obtain the optimum insole design by FE analysis.

3. RESULT & DISCUSSION

At this stage, the legs are scanned and FE analysis of completed models is a normal foot. Forward in this paper will show some leg scanned people with foot deformities as well as analysis of FE model. The scans feet quickly drawn 2 can be raised into a 3D surface / solid modelling indenter foot and shoe orthotic insole with the help of software PowerSHAPE 2015.

CBS strategy quickly modelling, precision and precisely able to generate the curve formed by the 3D surface meshes foot into shoe insole that perfectly matches the specifications used CAD computer. By using features create an oblique curve in PowerSHAPE 2015, will be generated curve corresponding insole contours on the feet that are scanned.

For the validation of the foot and ankle models, Fig. 5 shows that the stress distribution pattern was similar to Reviews those experimental data is in the literature [9,12, 14,15], are relatively higher in the which the stresses were located in the rearfoot and forefoot.

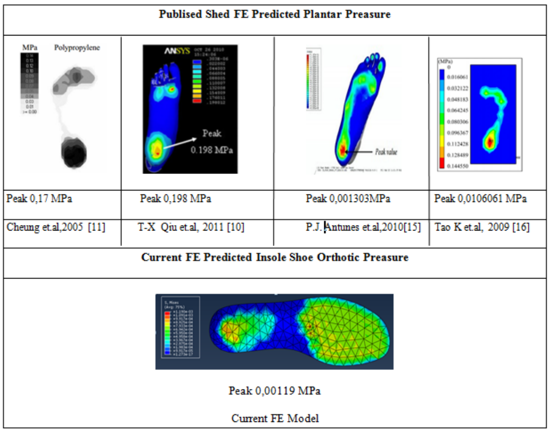

Fig.5.Comparison of predicted plantar pressure with published experiment data.

Based on Figure 5, The current FE Orthotic Shoe Insole Pressure for normal foot already on the direction and position of the peak von miss stress the same, that is on the heel bone. The amount of peak von miss stress in this section is causing excessive pain for people with foot deformities. Thus, in the design of shoe orthotic insole needs to be determined optimal gap width between the legs with a insole heel bone is located.

From the wide gap that has been set turns von miss stress occurs at the smallest gap width 1,75mm to load foot 150N - 450N.

4. CONCLUSION

RID developed technology applications help researchers FE analysis Abaqus 6:13 managed to get an orthotic shoe insole with von miss stress in peak condition for 1.190 x10^{-3} MPa to 4 x10^{-4} MPa at the heel bone to the gap width of 1.75 mm.

In this paper will be displayed FE analysis on the design of orthotic insole shoe on the foot people with foot deformities with a wide gap between the upper foot insole varies.

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