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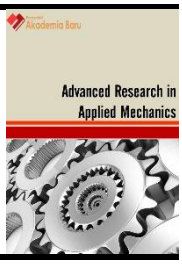

Anti- Fatigue Rubber Mat for Industrial Workplace: Load Pressure Analysis at Different Type of Mats

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ABSTRACT

The material from natural rubber/recycle rubber blends produced will be used as anti-fatigue mat for prolonged standing worker in the industrial workplace applications. Many industrial workplaces dealing with standing position worker especially in processes job. The employer believes that performing jobs in standing position will give more degree of freedom especially operating large machine which will increase the productivity. The commercialized anti-fatigue rubber mat was used to compare the load and pressure analysis between conventional and formulated anti-fatigue mats. The study focused on the contact area, force in % body weight, contact pressure, and force applied on to the mats. The result showed that the conventional mat gave highest pressure recorded at 0.15MPa. The high pressure contact will increase the fatigue condition thus increased the tiredness feeling. The commercial anti- fatigue mat gave lowest value (44.54%) of normalized force meaning that almost 55.5% bodyweight was absorbed by mat followed by formulated mat and conventional mat.

Keywords:
Anti-fatigue mat, recycle rubber, load distribution

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1. Introduction

Standing position has proven was the popular position among the industrial worker especially for processes jobs. The advantages to perform job in standing provide worker large degree of freedom to move and performing job. Some works required walking distance, pushing and pulling activities. Thus, workers are preferred standing than sitting position. The design of machine which require standing position lead the worker no choice to choose working position. The last reasons why worker prefers to standing is no sitting facility equipped in the works station.

Standing position always refer to the versatile, free moving posi-tion, and high degree of freedom. This leads the worker more productive, innovative and working without pressure. However, if the worker standing in long period time, they will feel discomfort, tired, and leg muscle fatigue after completed their job. The worker may potentially expose to injury when 50 percent of working time was spent in standing position or considered as prolong standing. A worker is considered to be

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exposed to prolonged standing if he/ she spent over fifty percent of the total working hours during a full work shift in standing position [1]. Working in standing position for a long period of time has been recognized as a vital contribution to decrease workers' performance in industry. It includes occupational injuries, productivity decrement, increased of treatment and medical costs, and demoralizes workers. When workers perform jobs in prolonged standing, static contraction occurred particularly in their back and legs, thus resulted in diminished function of calf muscle [2]. However, most studies has also identi-fied prolonged standing as the most significant predictor of Musculoskeletal disorders (MSD) [3,4]

In order to overcome this problem, researchers found that the body contact pressure and load distribution can be reduced by using mat during standing. Research study found that prolong standing on the mat will reduced the fatigue and prevent from any injuries. The purpose of this study was to evaluate the performance of different mat on the presure and load distribution.

2. Methods

2.1 Subject

Three workers participated in this experiment. All of them were worker, whose directly working in standing position almost 60% of working time. Their range weight was from 60kg to 100kg. They were all in good health and had no history of injuries or significant back or leg pain.

2.2 Experimental Design

The experiment was designed to test fatigue effects when a subject was standing on a different type of mat. Three different mats namely as normal mat, commercial anti-fatigue mat, and KAH-MAT4 were selected in this experiment.

2.3 Pressure Measuring System

Pressure was recorded with an F-SCAN® 7.5X USER MANUAL Bipedal in-shoe pressure / force measurement system. This system senses the dynamic barefoot pressures as they are happening (in real time), presents the information as a vivid 2D or 3D color-coded display, and allows to record the information (as a "movie") for later review and analysis. In this way, it can focus on specific areas and qualitatively compare the pressure patterns in those areas - before and after treatment. Before a new test floor was measured the sensor maps were pneumatically equilibrated with individual body weight of client. This equilibration was used to compensate possible changes in the sensitivity of sensors throughout the measurement period. This study focused on the load and pressure distribution at different type of mats.

2.4 Data Recording

Clients were equipped with 2 F-Scan Sensors (Model #3000E) with Versatek Edge. The gait cycle variables were extracted using F-Scan system by recording the pattern of gait and segmentation analysis during walking progress on the mat. Kinematic gait anal-ysis allows basic gait parameters such as walking speed, stride length, stride speed, swing and stance phase to be determined [5]

3. Results and Discussion

3.1 Dynamic Pressure Profiling Analysis

In this study, commercialized anti-fatigue rubber mat was used to compare the load and pressure analysis between conventional and formulated anti-fatigue mats. The study focused on the contact area, force in % body weight, contact pressure, and force applied on to the mats. Table 1 showed the dynamic analysis at different type of mats. During walking, the mat will absorb impact/load, and return energy to the foot while striding. The low impact, high contact area, and energy conserve will correlates with less pain and fatigue. This properties will reduce pain especially back pain of the workers. Low back pain was also reported among standing workers who work continuously for two hours [6].

From the table 1, KAHMAT4 gave the highest contact area which the impact and energy will distribute well to the foot thus reduce the forced contact between foot and mat. The results showed that the force applied on KAHMAT4 is 459.04N (lowest) compared to the other with high contact area recorded. From Figure 2, the well force distribution will reduce the fatigue and tiredness of worker. The KAHMAT4 3D contour foot pressure shown the most uniform pressure distribution compared to other mats with lowest pressure value. The low pressure distribution value will reduced the fatigue condition thus minimize the back pain disorder.

Table 1
Dynamic pressure analysis at different types of mats

Parameter		Commercial anti-fatigue mat	Normal mat	KAH MAT4
Contact Area(cm^2)	**Left**	88.73	64.52	120.77
	Right	93.42	95.23	123.35
	Average	91.08	79.88	122.06
% body weight	**Left**	37.20	50.20	36.90
	Right	51.70	50.10	62.00
	Average	44.45	50.15	49.45
Contact Pressure (Mpa)	**Left**	0.06	0.08	0.03
	Right	0.04	0.05	0.05
	Average	0.05	0.07	0.04
Force(N)	**Left**	553.28	516.88	379.67
	Right	382.78	382.78	538.42
	Average	468.03	468.03	459.05

3.2 Pressure and Percent Body Weight

One of the important analysis is reducing body weight balance during walking through the mat. The low normalized force (body weight %) indicated better contact between foot and mat. The low body weight % indicates high bodyweight is absorbed on the mat. The commercial anti- fatigue mat gave lowest value (44.54%) meaning that almost 55.5% bodyweight was absorbed by mat followed by KAHMAT4 and conventional mat (Figure 3). For a person walking normally there are contact phases which are characterized by relatively short temporal phases. During work we tend to make small movements, which leads to increasing articular constraints as well as muscular-skeletal problems.

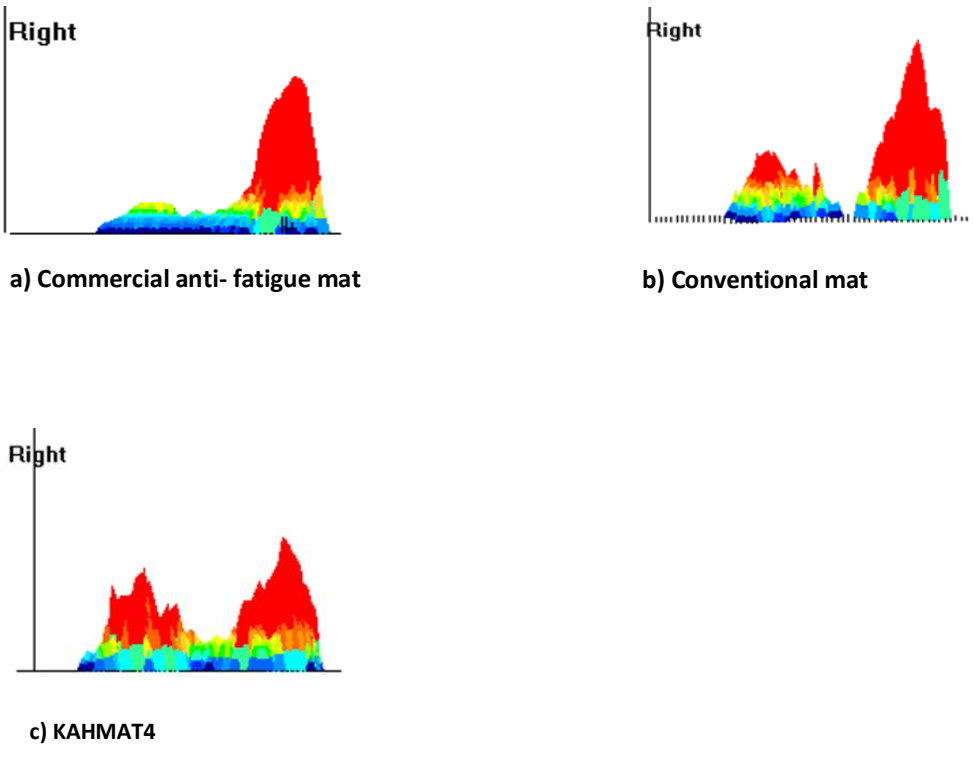

Fig. 2. 3D contour of foot pressure distribution at different mats

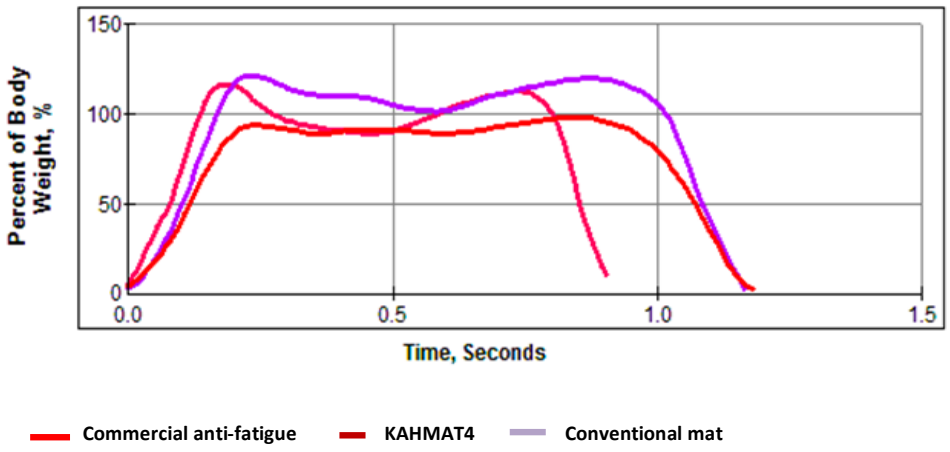

Fig. 3. Percent of body weight over time during walking (dynamic) condition

The high pressure contact will increase the fatigue condition thus increased the tiredness feeling. Figure 4 showed the trend of pressure to time during walking condition. The conventional mat gave highest average value of pressure (0.07MPa) with highest pressure recorded at 0.15Mpa.The thickness and softness of the mat will affected the pressure value.

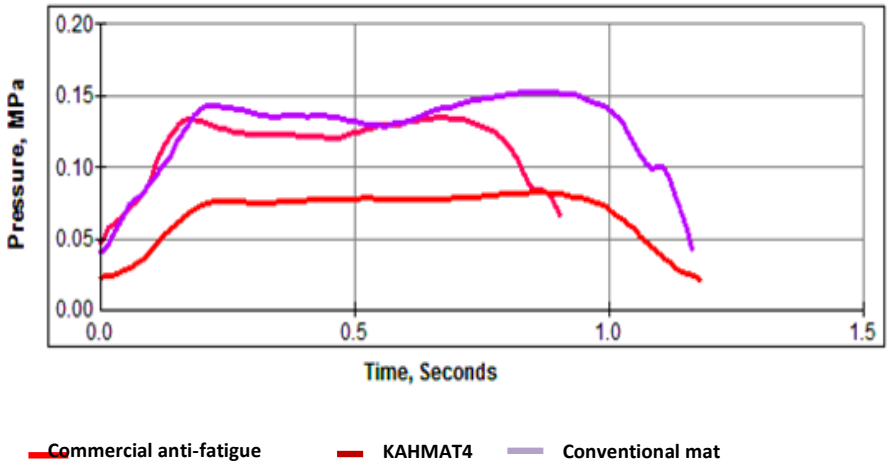

Fig. 4. Pressure analysis over time during walking (dynamic) condition

4. Conclusion

KAHMAT 4 mat gave the better performance compare to the conventional and commercial anti -fatigue mat. However, this finding was limited in order to conclude the most effective mat to reduce fatigue condition. Further studies need to be conducted especially in musculoskeletal disorder analysis to support the effectiveness of anti -fatigue mat on the muscle activity over prolong periods of time.

Acknowledgement

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References

[1] Halim, Isa, and Abdul Rahman Omar. "A review on health effects associated with prolonged standing in the industrial workplaces." *IJRRAS* 8, no. 1 (2011): 14-21.
[2] Krijnen, R. M. A., E. M. De Boer, H. J. Ader, and D. P. Bruynzeel. "Diurnal volume changes of the lower legs in healthy males with a profession that requires standing." *Skin research and technology* 4, no. 1 (1998): 18-23.
[3] Andersen, Johan H., Jens P. Haahr, and Poul Frost. "Risk factors for more severe regional musculoskeletal symptoms: A two-year prospective study of a general working population." *Arthritis & Rheumatism* 56, no. 4 (2007): 1355-1364.
[4] Tissot, France, Karen Messing, and S. Stock. "Studying the relationship between low back pain and working postures among those who stand and those who sit most of the working day." *Ergonomics* 52, no. 11 (2009): 1402-1418.
[5] Clayton, Hilary M. "Gait analysis comes of age." *Veterinary journal (London, England: 1997)* 157, no. 1 (1999): 5.
[6] Gregory, Diane E., and Jack P. Callaghan. "Prolonged standing as a precursor for the development of low back discomfort: an investigation of possible mechanisms." *Gait & posture* 28, no. 1 (2008): 86-92.