BAB 6 KESIMPULAN

6.1. Kesimpulan

Dari penelitian yang telah dilakukan maka dapat ditarik kesimpulan bahwa proses pemodelan yang dilakukan untuk EVA rubber menggunakan indenter *ballnose HSS* dapat disimulasi dengan laptop penulis dan dengan PC yang berada Laboratorium Proses Produksi UAJY menggunakan software Abaqus 6.13. telah sesuai dengan yang diharapkan oleh penulis. Hasil simulasi yang diperoleh penulis dari penelitian ini untuk masing-masing pemodelan mendapatkan beberapa nilai tekanan maksimal yang dapat dilihat dilampiran 1 pada gambar 1 sampai 75 dan lampiran 2 pada gambar 76 sampai gambar 150.

Proses simulasi juga menunjukan bahwa nilai tegangan maksimal material NORA SLW lebih tinggi dari pada material EVA yaitu pada nilai 0.1966 MPa sampai 1.484 MPa untuk material EVA, sedangkan untuk material NORA SLW berkisar 0.2116 sampai 1.516 MPa pada ketebalan 20 mm dengan indenter 4 mm.

Hasil pemberian variasi ketebalan pada material uji tidak memberikan efek pembebanan yang signifikan terhadap besarnya nilai tekanan yang dihasilkan. Namun pada saat diberikan variasi diameter dari indenter Ballnose HSS antara diameter 4 mm dan diameter 6 mm akan memberikan efek pembebanan yang signifikan terhadap besarnya nilai tekanan yang dihasilkan.

Hasil verifikasi dari simulasi yang dilakukan dapat menunjukan kurva SEF antara material EVA memiliki nilai tegangan maksimal 7.67808 MPa dan untuk NORA memiliki nilai tegangan maksimal 8.61254 MPa pada regangan 400% sudah searah dan *present model* yang dibuat memiliki kemiripan. Persamaan matematis yang dihasilkan ke dua material yaitu untuk EVA *rubber* adalah y = $-0.004x^2 + 0.337x + 1.548$ dengan R² = 0.928 dan untuk NORA SLW adalah y = $-0.005x^2 + 0.389x + 1.886$ dengan R² = 0.915.

6.2. Saran

Saran dari penulis untuk penelitian selanjutnya adalah dapat dilakukannya penelitian lebih lanjut mengenai FEA pada insole sepatu orthotic sehingga dapat

mempermudah saat dilakukannya proses manufacturing, juga perlu dilakukan penelitian pada kaki manusia yang normal dan bermasalah untuk mengetahui apakah ada perbedaan dari hasil kurva tegangan-regangan yang didapatkan. Serta perlu dilakukan variasi lapisan pada pembuatan insole sepatu menggunakan pengembangan model FEA yang lainnya seperti pengembangan model Neo – Hookean, Ogden, Yeoh, Arruda – Boyce, Gent, Blatz – Ko, dimana yang penulis lakukan hanya memodelkan dalam satu lapis dengan menggunakan model Mooney – Rivlin.



DAFTAR PUSTAKA

- Arayapranee, W. (2012). *Rubber Abrassion Resistance*. Rangsit University. Thailand.
- Delcam, Plc.; *PowerMILL & PowerSHAPE Training Course*2014, Delcam UK, Talbot Way, Small Heath Business Park, Brimingham B10 0HJ; 2012
- Fukahori, Y. Liang, H. Busfield, J.J.C. (2008). *Criteria for crack initiation during rubber abrasion.* University of London. London.
- Gallagher, Richard H. (1975). *Finite Element Analysis: Fundamentals*. Prentice-Hall, Englewood Cliffs, N. J.,
- Garcia, R, Manuel, J. Ruiz, S, Oscar, E. Lopes, C. (2005). *Hyperelastic Material Modeling.* Universidad EAFIT. Medellin. 5-21.
- Hong Tiang; Nannaji Saka; (1991); Finite element analysis of an elastic-plastic two layer half-space: normal contact; *Wear*, vol. 148; pp 47-68.
- Jason Tak-Man Cheung; Ming Zhang; (2006); Finite Element Modeling of the HumanFoot and Footwear; ABAQUS User's Conference, pp 145-159.
- Liang, H. (2007). *Investigating the Mechanism of Elastomers Abrasion*. University of London. London. 25-131.

Schreiber, Jeremy H. (2015). Prediction of fragmentation and experimentally inaccessible material properties of steel using finite element analysis. ThePennsylvania State University. University Park, PA 16802, USA.

Wicahyo , Feri Dwi. (2014) Pengaruh *Wedge Angel* Pada *Blade Indenter* dalam pengujian tekanan material *Hyperelastic* menggunakan metode elemen hingga. Universitas Diponegoro, Semarang.

www.artikelcad.com/2014/09/arti-dari-definisi-dan-perbedaan-cad.html

diakses pada tanggal 06-02-2015

www.republika.co.id/berita/ekonomi/bisnis/13/09/10/mswfp7-potensi-industri-

karet indonesia-terbuka-lebar, diakses pada tanggal 21-09-2015

- Yanping Cao; Duancheng Ma; Dierk Raabe, (2009); The use of flat punch indentation to determine the viscoelastic properties in the time and frequency domains of a soft layer bonded to a rigid substrate; *J. Acta Biomaterialia:* vol.5, pp 240-248.
- Zang, S. (2004). Tribology Of Elastomers. University of Petroleum. Beijing.China.



Lampiran 1

Material Ethylene Vinyl Acetate (EVA)

Layer 20 mm

Diameter Ballnose HSS 4 mm



Gambar 47. EVA pada tekanan 2 N



Gambar 48. EVA pada tekanan 3 N

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Gambar 49. EVA pada tekanan 4 N

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Gambar 50. EVA pada tekanan 5 N

Material Ethylene Vinyl Acetate (EVA)

Layer 20 mm

Diameter Ballnose HSS 6 mm

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Gambar 51. EVA pada tekanan 1 N



Gambar 53. EVA pada tekanan 3 N



Gambar 55. EVA pada tekanan 5 N



Gambar 57. EVA pada tekanan 7 N



Gambar 58. EVA pada tekanan 8 N

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Gambar 59. EVA pada tekanan 9 N



Gambar 60. EVA pada tekanan 10 N

Lampiran 2

Material NORA SLW

Layer 20 mm

Diameter Ballnose HSS 4 mm



Gambar 122. NORA SLW pada tekanan 2 N

Gambar 124. NORA SLW pada tekanan 4 N

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Gambar 125. NORA SLW pada tekanan 5 N

Material NORA SLW

Layer 20 mm

Diameter Ballnose HSS 6 mm

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Gambar 126. NORA SLW pada tekanan 1 N

Gambar 128. NORA SLW pada tekanan 3 N

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Gambar 130. NORA SLW pada tekanan 5 N

Gambar 132. NORA SLW pada tekanan 7 N

Gambar 134. NORA SLW pada tekanan 9 N

Gambar 135. NORA SLW pada tekanan 10 N

Lampiran 3

NORA SLW		
Nominal	Nominal	
Stress	Strain	
0	0	
0.1	1.59384	
0.2	2.72467	
0.3	3.55539	
0.4	4.18453	
0.5	4.67414	
0.6	5.06462	
0.7	5.38307	
0.8	5.64814	
0.9	5.87294	
1	6.0669	
1.1	6.2369	
1.2	6.38805	
1.3	6.5242	
1.4	6.64829	
1.5	6.7626	
1.6	6.86889	
1.7	6.96857	
1.8	7.06275	
1.9	7.15232	
2	7.23801	
2.1	7.32042	
2.2	7.40002	
2.3	7.47722	
2.4	7.55235	
2.5	7.62569	
2.6	7.69748	
2.7	7.76792	
2.8	7.83716	
2.9	7.90537	
3	7.97265	
3.1	8.03912	
3.2	8.10487	

EVA Rubber				
Nominal	Nominal			
Stress	Strain			
0	0			
0.1	1.33437			
0.2	2.28619			
0.3	2.98974			
0.4	3.52634			
0.5	3.94721			
0.6	4.28578			
0.7	4.56447			
0.8	4.79873			
0.9	4.99943			
1	5.1744			
1.1	5.32936			
1.2	5.46855			
1.3	5.59519			
1.4	5.71173			
1.5	5.82005			
1.6	5.92164			
1.7	6.01767			
1.8	6.10907			
1.9	6.19658			
2	6.28083			
2.1	6.3623			
2.2	6.4414			
2.3	6.51846			
2.4	6.59378			
2.5	6.66757			
2.6	6.74005			
2.7	6.81138			
2.8	6.8817			
2.9	6.95113			
3	7.01977			
3.1	7.08773			
3.2	7.15506			

3.3	8.16997	3.3	7.22185
3.4	8.2345	3.4	7.28815
3.5	8.29852	3.5	7.354
3.6	8.36208	3.6	7.41946
3.7	8.42522	3.7	7.48457
3.8	8.48799	3.8	7.54935
3.9	8.55042	3.9	7.61385
4	8.61254	 4	7.67808

Table 1. Data Kurva SEF pada Material NORA SLW VS EVA Rubber

Data Pengaruh Geometri Indenter Terhadap Kedalaman Indentasi

Concentrated	Diameter 4	Diameter 6	Diameter 4 (EVA	Diameter 6 (EVA
Force	(NORA SLW)	(NORA SLW)	Rubber)	Rubber)
0	0	0	0	0
1 N	0.2257	0.07563	0.2067	0.1111
2 N	0.484	0.1976	0.4422	0.23
3 N	0.7833	0.3291	0.7144	0.3576
4 N	1.135	0.4736	1.033	0.4951
5 N	1.825	0.6325	1.877	0.6518
6 N		1.016		0.9215
7 N		1.365		1.158
8 N		1.714		1.355
9 N		2.051		1.548
10 N		2.389		1.764

Tabel 2. Data Pengaruh Geometri Indenter Terhadap Kedalaman Indentasi Layer 5

Concentrated Force	Diameter 4 (NORA SLW)	Diameter 6 (NORA SLW)	Diameter 4 (EVA Rubber)	Diameter 6 (EVA Rubber)
0	0	0	0	0
1 N	0.2116	0.07595	0.1966	0.1081
2 N	0.4512	0.1985	0.4188	0.2235
3 N	0.726	0.3308	0.6727	0.3473
4 N	1.044	0.4751	0.9663	0.4805
5 N	1.516	0.6284	1.484	0.6303
6 N		0.9461		0.9057
7 N		1.288		1.106
8 N		1.58		1.29
9 N		1.861		1.487

10 N 2.147 1.699

Concentrated	Diameter 4	Diameter 6	Diameter 4	Diameter 6
Force	(NORA SLW)	(NORA SLW)	(EVA Rubber)	(EVA Rubber)
0	0	0	0	0
1 N	0.212	0.07584	0.1972	0.1083
2 N	0.4523	0.198	0.42	0.224
3 N	0.7279	0.331	0.6751	0.3481
4 N	1.048	0.4746	0.9708	0.4817
5 N	1.547	0.629	1.52	0.6368
6 N	2	0.9679		0.9169
7 N		1.303		1.115
8 N		1.603		1.306
9 N		1.893		1.508
10 N		2.183		1.721

Tabel 3. Data Pengaruh G	Geometri Indenter 7	Ferhadap Kedalaman	Indentasi Laver 10

Concentrated	Diameter 4	Diameter 6	Diameter 4	Diameter 6 (EVA
Force	(NORA SLW)	(NORA SLW)	(EVA Rubber)	Rubber)
0 N	0	0	0	0
1 N	0.2116	0.07595	0.1966	0.1081
2 N	0.4512	0.1985	0.4188	0.2235
3 N	0.726	0.3308	0.6727	0.3473
4 N	1.044	0.4751	0.9663	0.4805
5 N	1.516	0.6284	1.484	0.6303
6 N		0.9461		0.9057
7 N		1.288		1.106
8 N		1.58		1.29
9 N		1.861		1.487
10 N		2.147		1.699

Tabel 5. Data Pengaruh Geometri Indenter Terhadap Kedalaman Indentasi Layer 20

Concentrated	Diameter 4	Diameter 6	Diameter 4 (EVA	Diameter 6 (EVA
Force	(NORA SLW)	(NORA SLW)	Rubber)	Rubber)
0	0	0	0	0
1 N	0.2116	0.07595	0.1966	0.1081
2 N	0.4512	0.1985	0.4188	0.2235
3 N	0.726	0.3308	0.6727	0.3473
4 N	1.044	0.4751	0.9663	0.4805
5 N	1.516	0.6284	1.484	0.6303

6 N	0.9461	0.9057
7 N	1.228	1.106
8 N	1.58	1.29
9 N	1.861	1.487
10 N	2.147	1.699

Tabel 6. Data Pengaruh Geometri Indenter Terhadap Kedalaman Indentasi Layer 30

