ANALISA KEKUATAN SPIRAL BEVEL GEAR DENGAN VARIASI SUDUT SPIRAL MENGGUNAKAN METODE ELEMEN HINGGA

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LATAR BELAKANG

Efisiensi
Kemampuan Transmisi Daya
Vibrasi & Noise

- **Perhitungan Analitis Spiral Bevel Gear Rumit**
- **Pendekatan Perhitungan Analitis dengan Straight Bevel Gear**

Pendekatan perhitungan dengan metode elemen hingga

RUMUSAN MASALAH

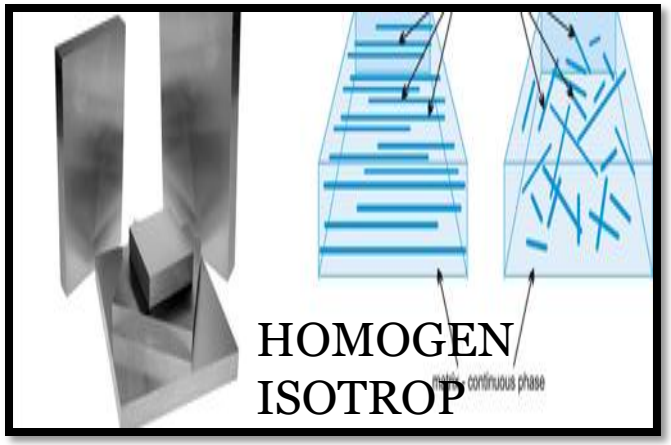
- Bagaimana pemodelan 3D *straight bevel gear* dan *spiral bevel gear* ?
- Berapa selisih tegangan bending yang terjadi sepanjang kaki gigi pada *straight bevel gear* dan *spiral bevel gear*?
- Berapa selisih tegangan kontak yang terjadi pada gigi *straight bevel gear* dan *spiral bevel gear* ?

TUJUAN PENILITIAN

- Untuk mendapatkan pemodelan 3D *straight bevel gear* dan *spiral bevel gear*.
- Untuk mengetahui selisih tegangan bending yang terjadi sepanjang kaki gigi pada *straight bevel gear* dan *spiral bevel gear*.
- Untuk mengetahui selisih tegangan kontak yang terjadi pada gigi *straight bevel gear* dan *spiral bevel gear*.

20°
35°
45dan

BATASAN MASALAH

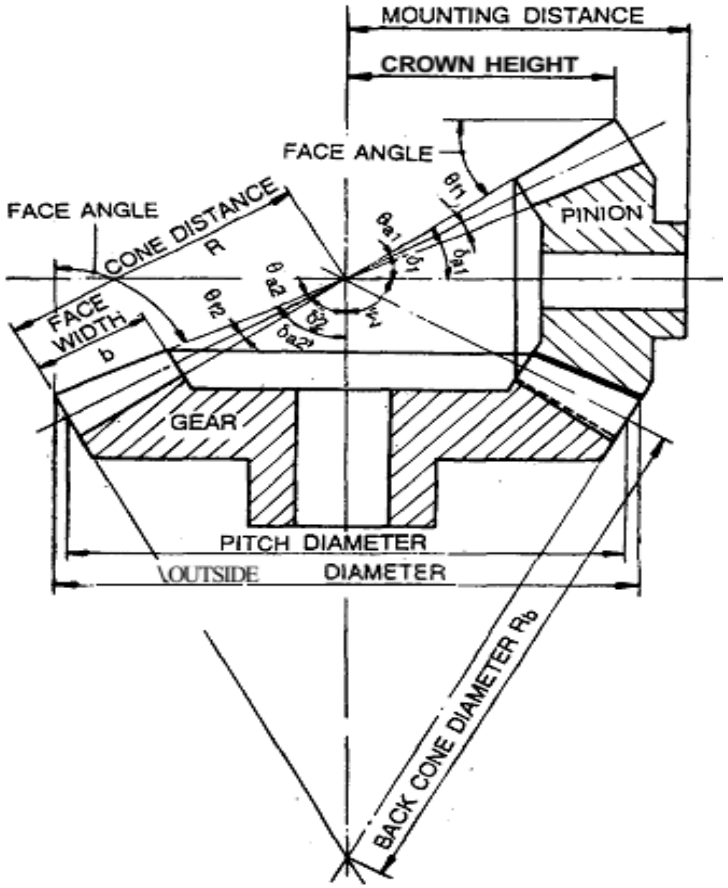


Variasi sudut *spiral* 20°, 35°, dan 45°.

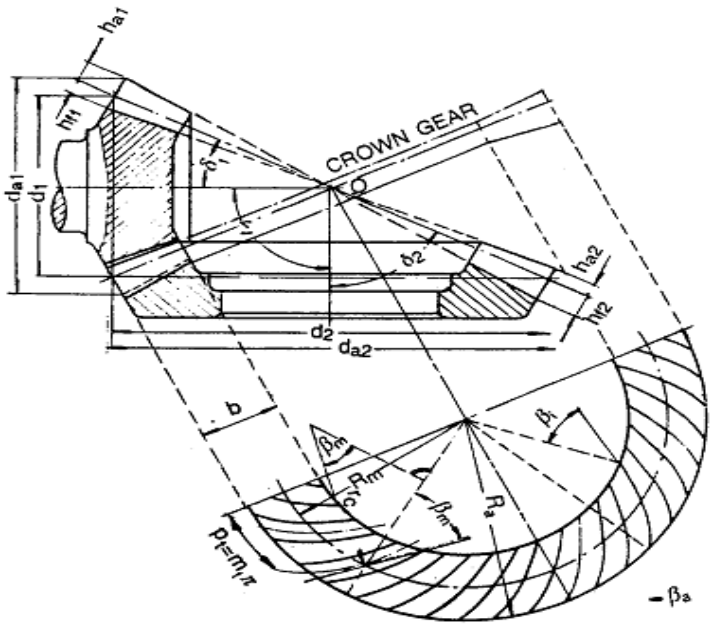
MANFAAT PENELITIAN

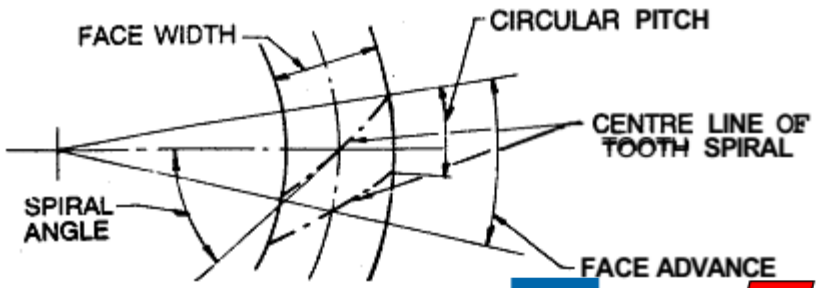
Dengan mengetahui selisih kekuatan antara *spiral bevel gear* dan *straight bevel gear*, maka biaya manufaktur *spiral bevel gear* dapat dikurangi dengan menurunkan *grade* material yang digunakan.

GEOMETRI STRAIGHT BEVEL GEAR

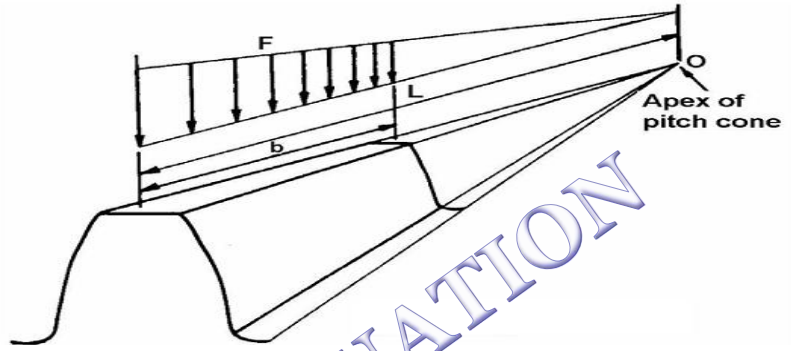


GEOMETRI SPIRAL BEVEL GEAR





Analisa Kekuatan Straight Bevel Gear



LEWIS EQUATION

$$F_b = \frac{\sigma Y b}{P}\left(1 - \frac{b}{L}\right)$$

Dimana :

F_b = Gaya bending

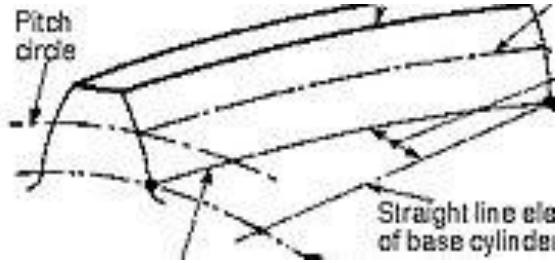
σ = Tegangan bending yang diijinkan dari material

P = Diameteral pitch

b = Face width

L = Jarak pitch ke apex

Y = Lewis factor



Allowable Wear

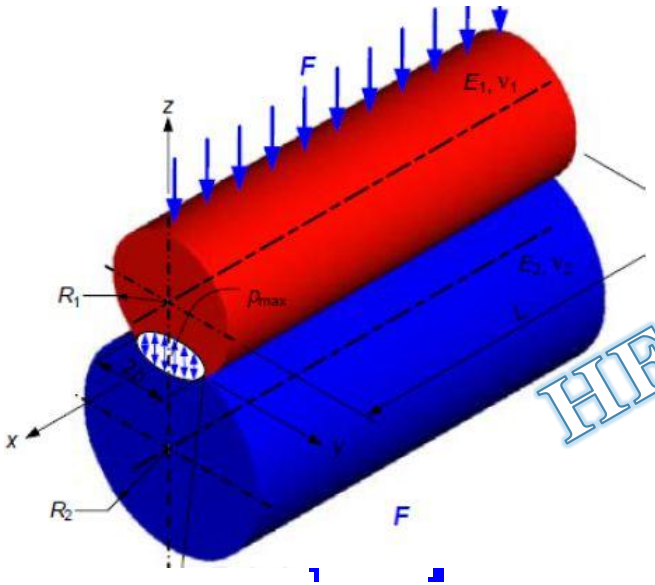
Buckingham

$$F_w = \frac{K\, d_p Q'}{Cosy}$$

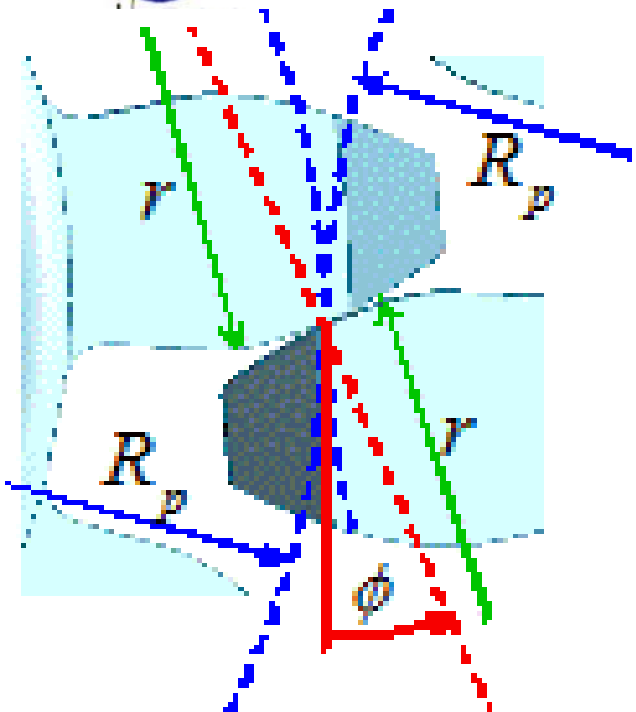
Dengan $$Q' = \frac{2N'_{tg}}{N'_{tp} + N'_{tg}}$$

$$K = \frac{\sigma_H^2 \sin\alpha \cos\alpha}{1.4}\left(\frac{1}{E_1} + \frac{1}{E_2}\right),$$

$$\sigma_H = \sqrt{\frac{2.T.cosy.1{,}4}{dp^2.Q'.sina.cosa.\left(\frac{1}{E1} + \frac{1}{E2}\right)}}$$



HERTZIAN



METODE ELEMEN HINGGA

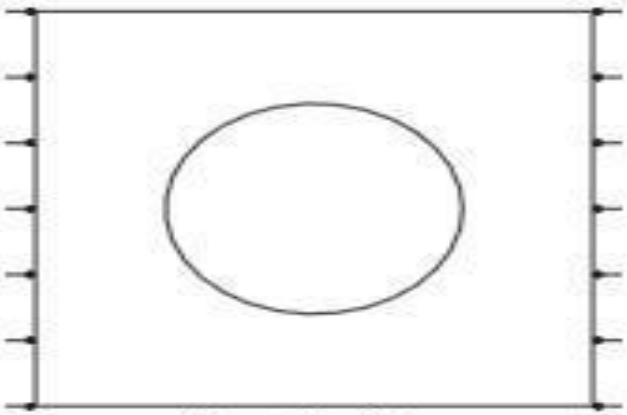
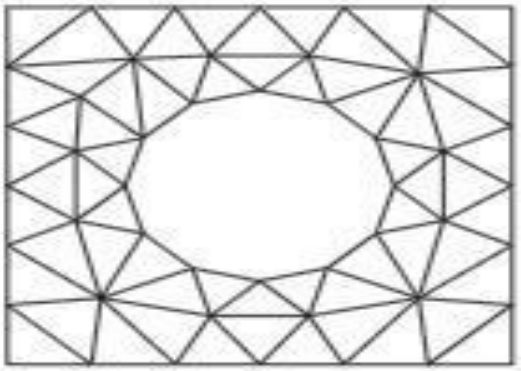


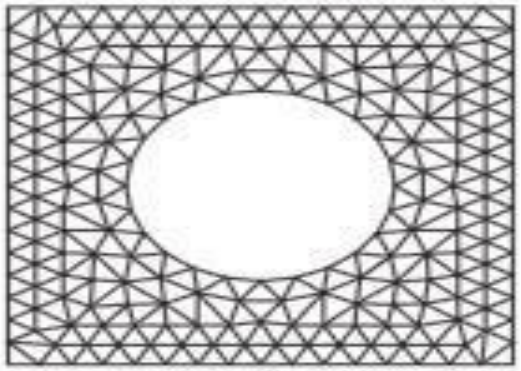
Plate with a Hole

Triangular Finite Element

- *Preprocessing*
- *Solution*
- *General Postprocessing*



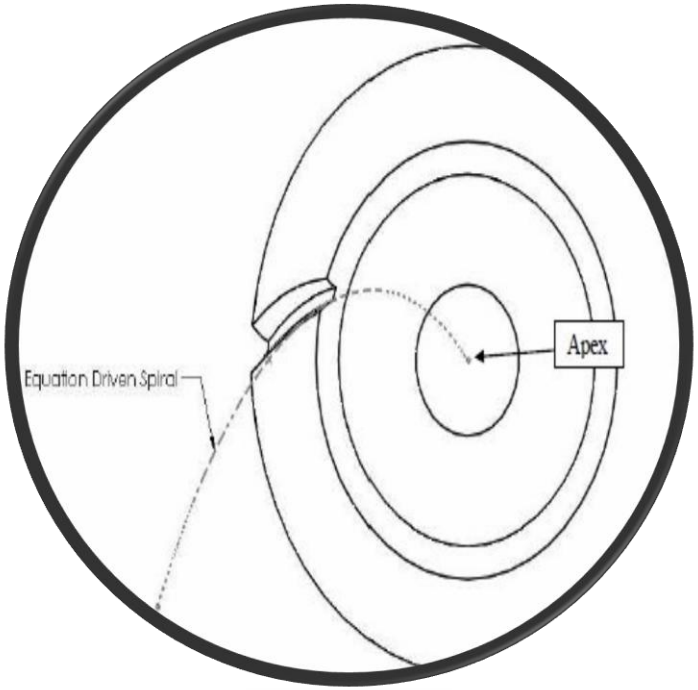
Finite Element Model



Refined Finite Element Model

PENELITIAN TERDAHULU

Baker J. Reynolds J. and Tecce, S.(2011).
"Parametric Design of a *Spiral Gear* Process"
Major Qualifying Report: JMS-1102 Worcester Polytechnic Institute.



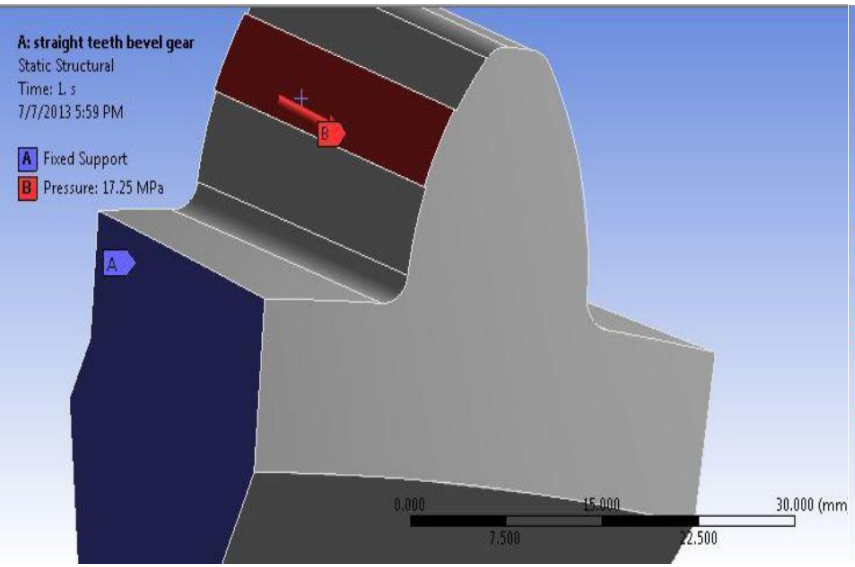
$$X(t)=Dg*t*\cos(t)$$
$$Y(t)= Dg*t*\sin(t)$$
$$Z(t)= K*t$$

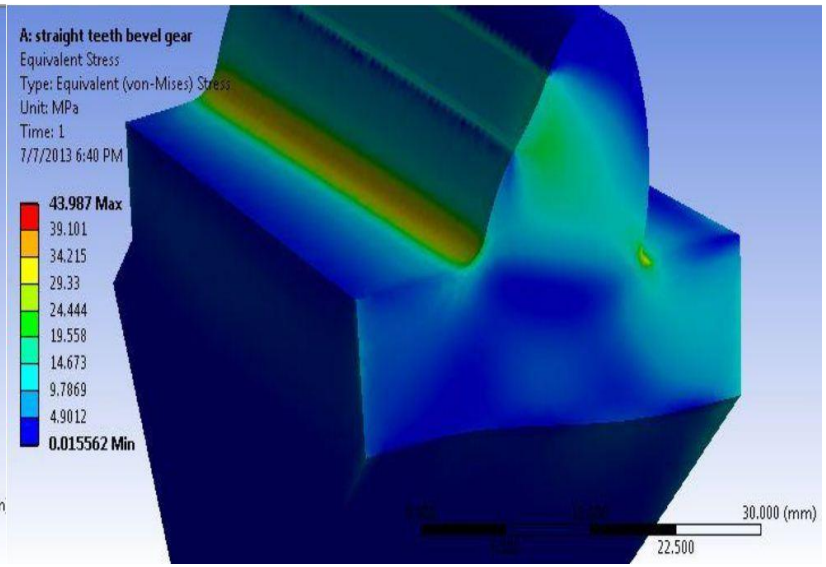
$$x(t) = rb(\cos(t)+t*\sin(t))$$
$$y(t) = rb(\sin(t)-t*\cos(t))$$

PENELITIAN TERDAHULU

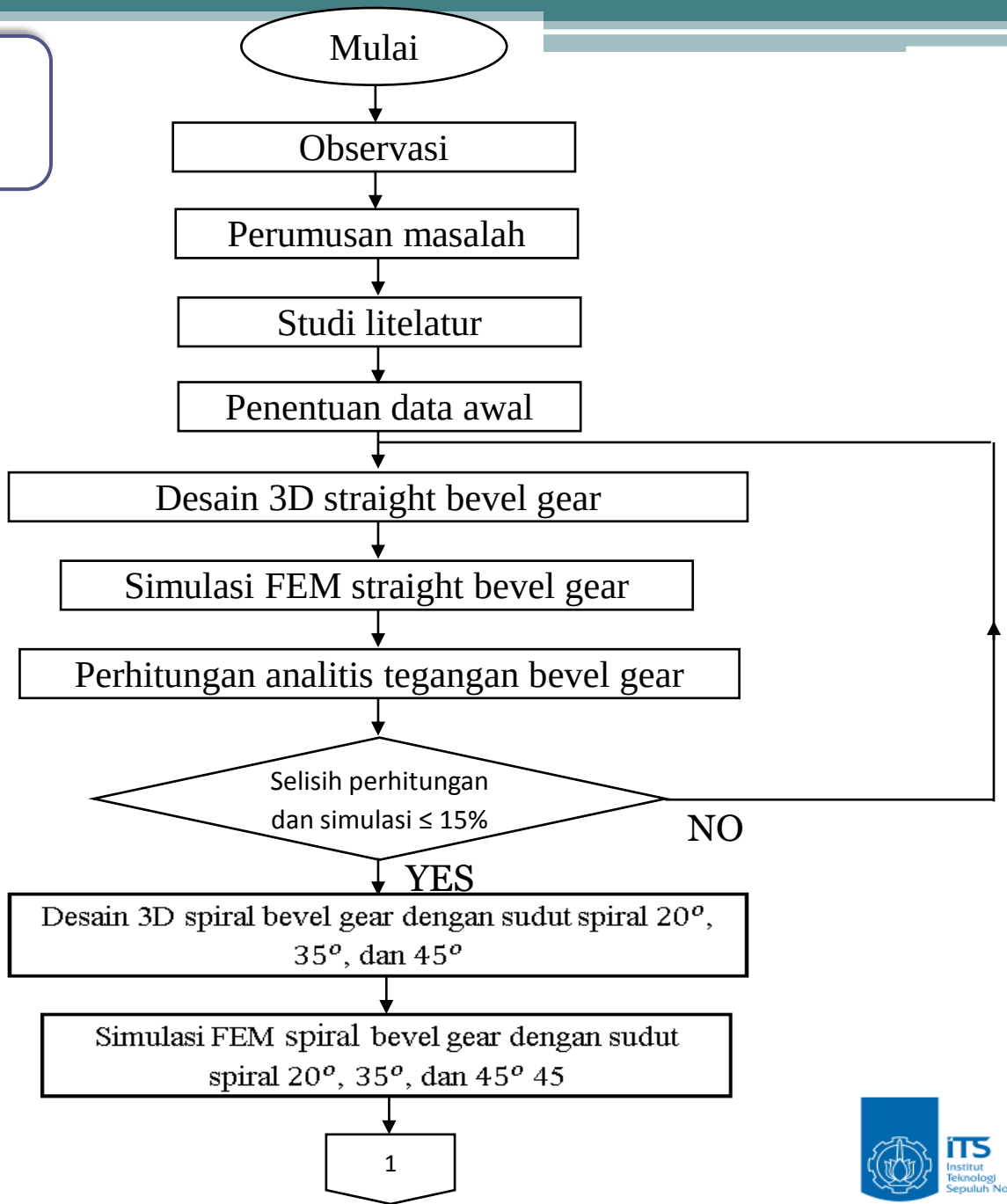
Ratnadeepsinh M.and Dipeshkumar M.(2013)
"Bending Stress Analysis of *Bevel Gears*"

International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 7.

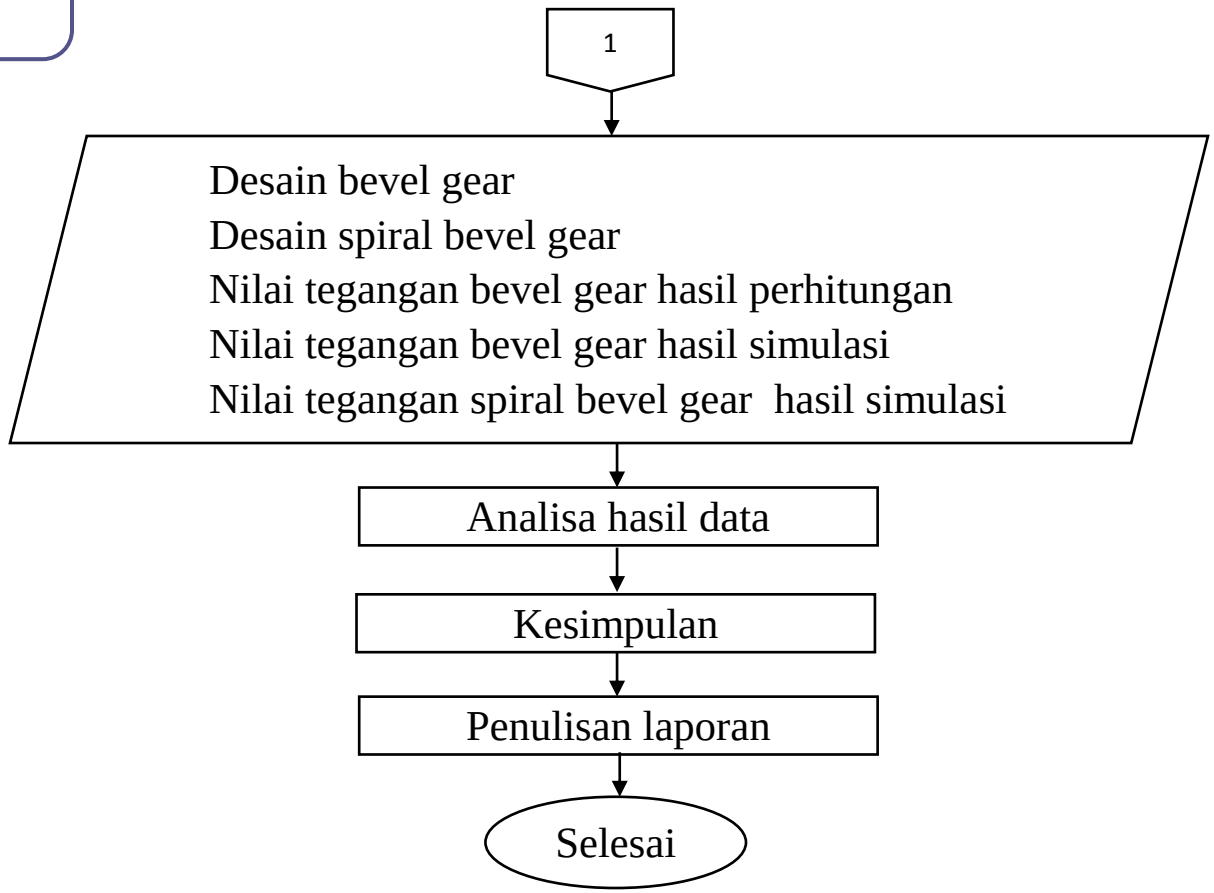




FLOWCHART PENELITIAN

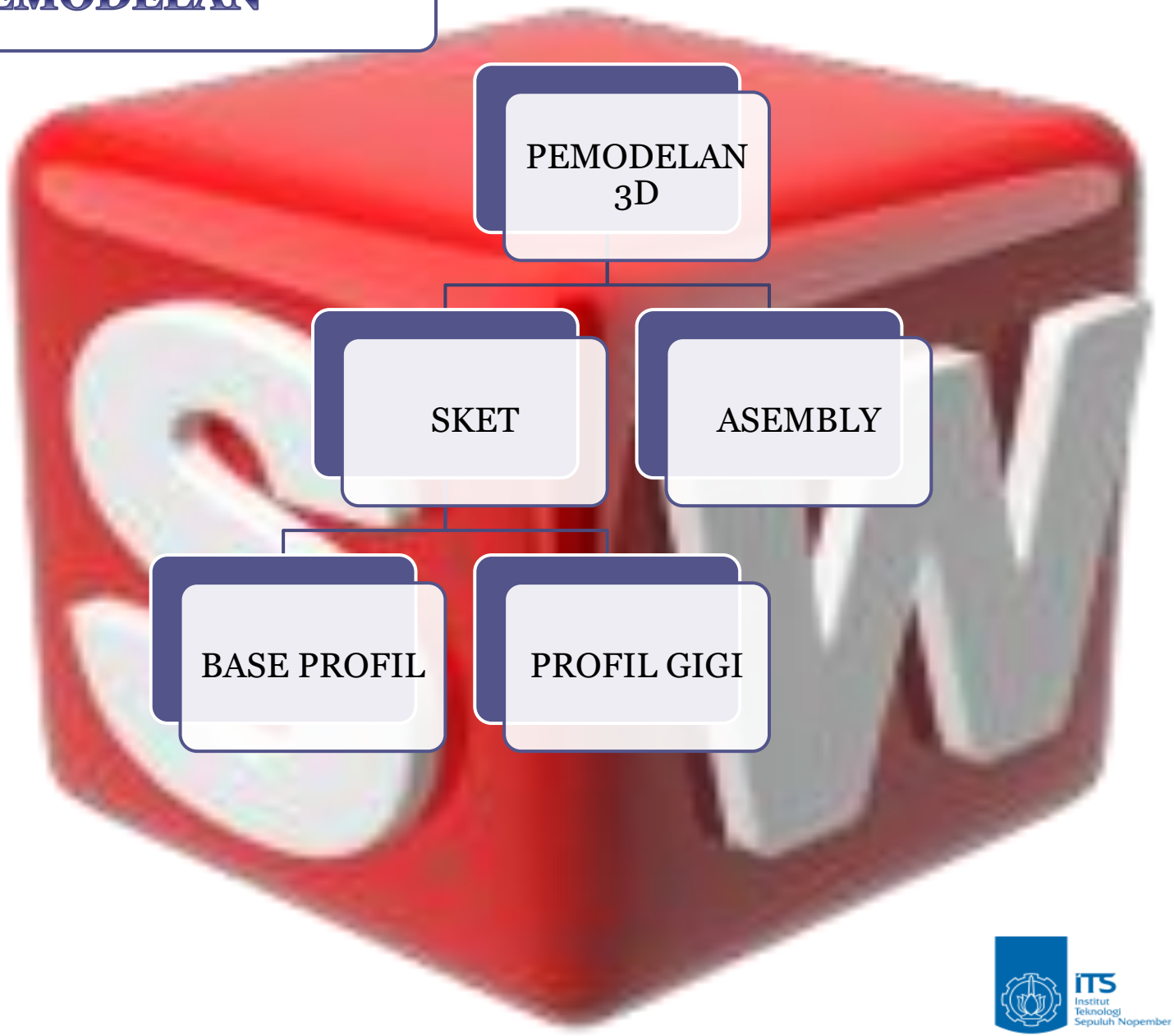


FLOWCHART PENELITIAN

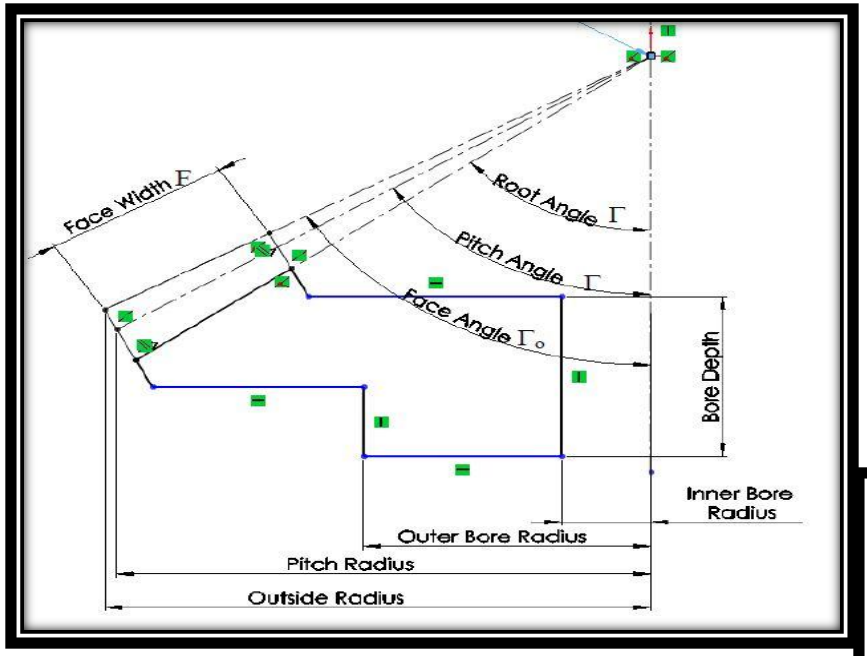


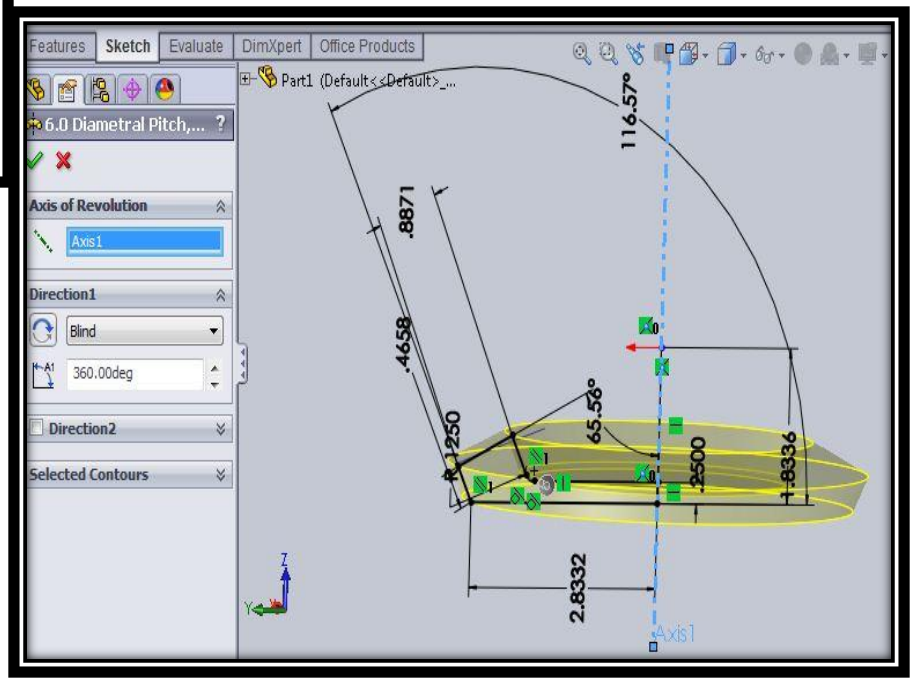
	Bevel Gear		spiral 20		spiral35		spiral45		
	Gear	Pn	gear	Pn	gear	Pn	gear	Pn	Sat
Diametral Pitch	6	6	6	6	6	6	6	6	
Modular	4.233	4.233	4.233	4.233	4.233	4.233	4.233	4.233	
Pressure Angle	20	20	20	20	20	20	20	20	deg
Spiral Angle	0	0	20	20	35	35	45	45	deg
Ratio, 1:x				1;2					
Shaft Angle	90		90		90		90		deg
Spiral direction			RH	LH	RH	LH	RH	LH	
Number of Teeth	36	18	36	18	36	18	36	18	
Face Width	1	1	1	1	1	1	1	1	in
Working Depth	0.333	0.333	0.283	0.283	0.283	0.283	0.283	0.283	in
Whole Depth	0.367	0.367	0.315	0.315	0.315	0.315	0.315	0.315	in
Pitch Diameter	6	3	6	3	6	3	6	3	in
Pitch Angle	63.43	26.57	63.43	26.57	63.43	26.57	63.43	26.57	deg
Cone Distance	3.354	3.354	3.354	3.354	3.354	3.354	3.354	3.354	in
Circular Pitch	0.524	0.524	0.524	0.524	0.524	0.524	0.524	0.524	in
Addendum	0.109	0.224	0.093	0.19	0.093	0.19	0.093	0.19	in
Dedendum	0.256	0.141	0.222	0.124	0.222	0.124	0.222	0.124	in
Clearance	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	in
Dedendum Angle	4.356	2.399	3.783	2.122	3.783	2.122	3.783	2.122	deg
Face Angle	65.83	30.92	65.56	30.35	65.56	30.35	65.56	30.35	deg
Root Angle	59.08	24.17	59.65	24.44	59.65	24.44	59.65	24.44	deg
Outside Diameter	6.098	3.401	6.083	3.341	6.083	3.341	6.083	3.341	in
Pitch Apex To Crown	1.402	2.9	1.417	2.915	1.417	2.915	1.417	2.915	in
Tooth Thickness	0.220	0.304	0.224	0.300	0.218	0.306	0.209	0.314	in
Fillet Radius	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	in
Backlash	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	in
Torque		2500		2500		2500		2500	lbf/in
Rotational velocity		1000		1000		1000		1000	rpm

PEMODELAN

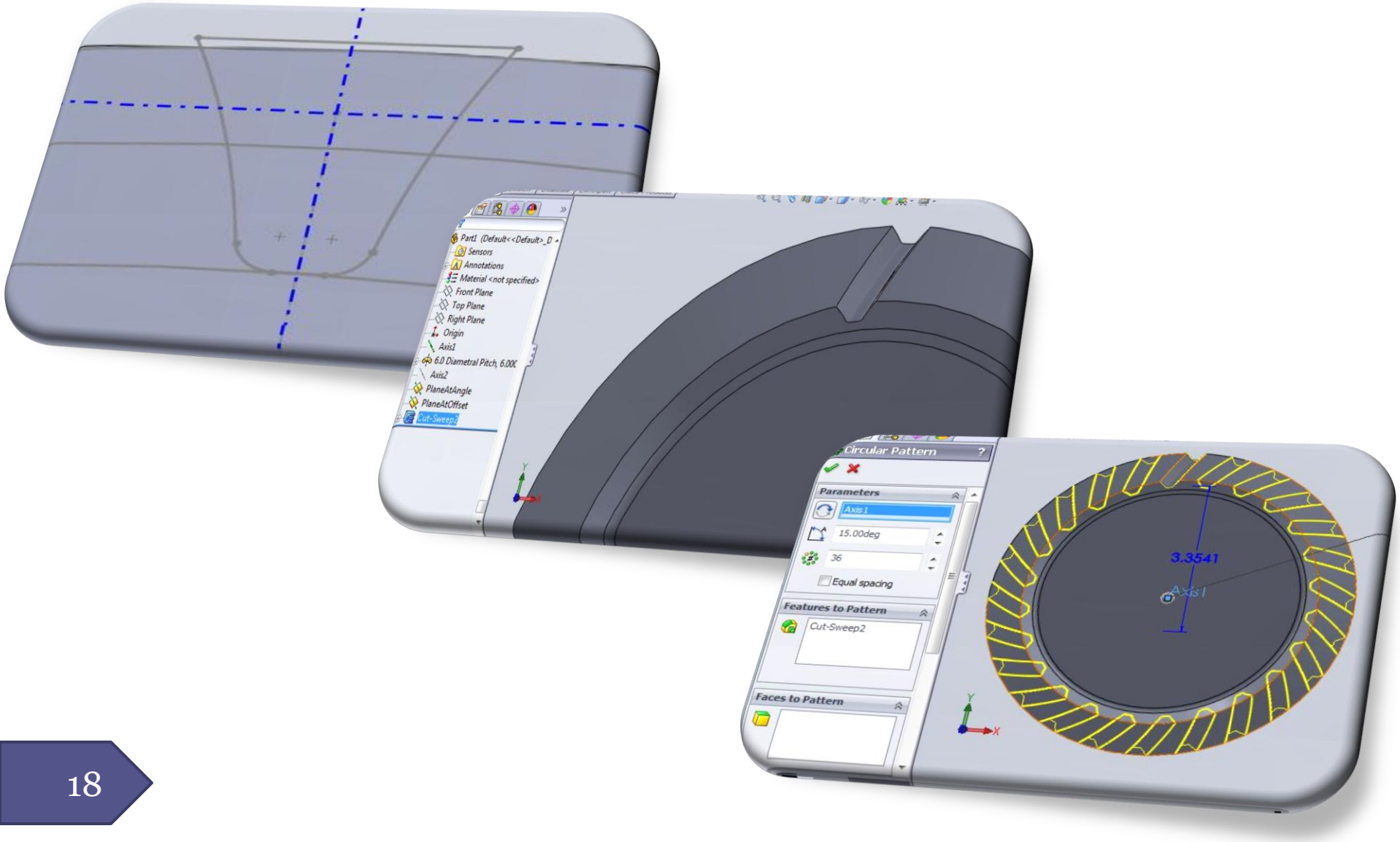


SKET BASE


Face Width F
Root Angle Γ
Pitch Angle Γ
Face Angle Γo
Bore Depth
Inner Bore Radius
Outer Bore Radius
Pitch Radius
Outside Radius


Features
Sketch
Evaluate
DimXpert
Office Products
Part1 (Default<<Default>_...
6.0 Diametral Pitch,...
Axis of Revolution
Axis1
Direction1
Blind
360.00deg
Direction2
Selected Contours
116.57°
.8871
.4658
.1250
65.56°
.2500
1.8336
2.8332
Axis1

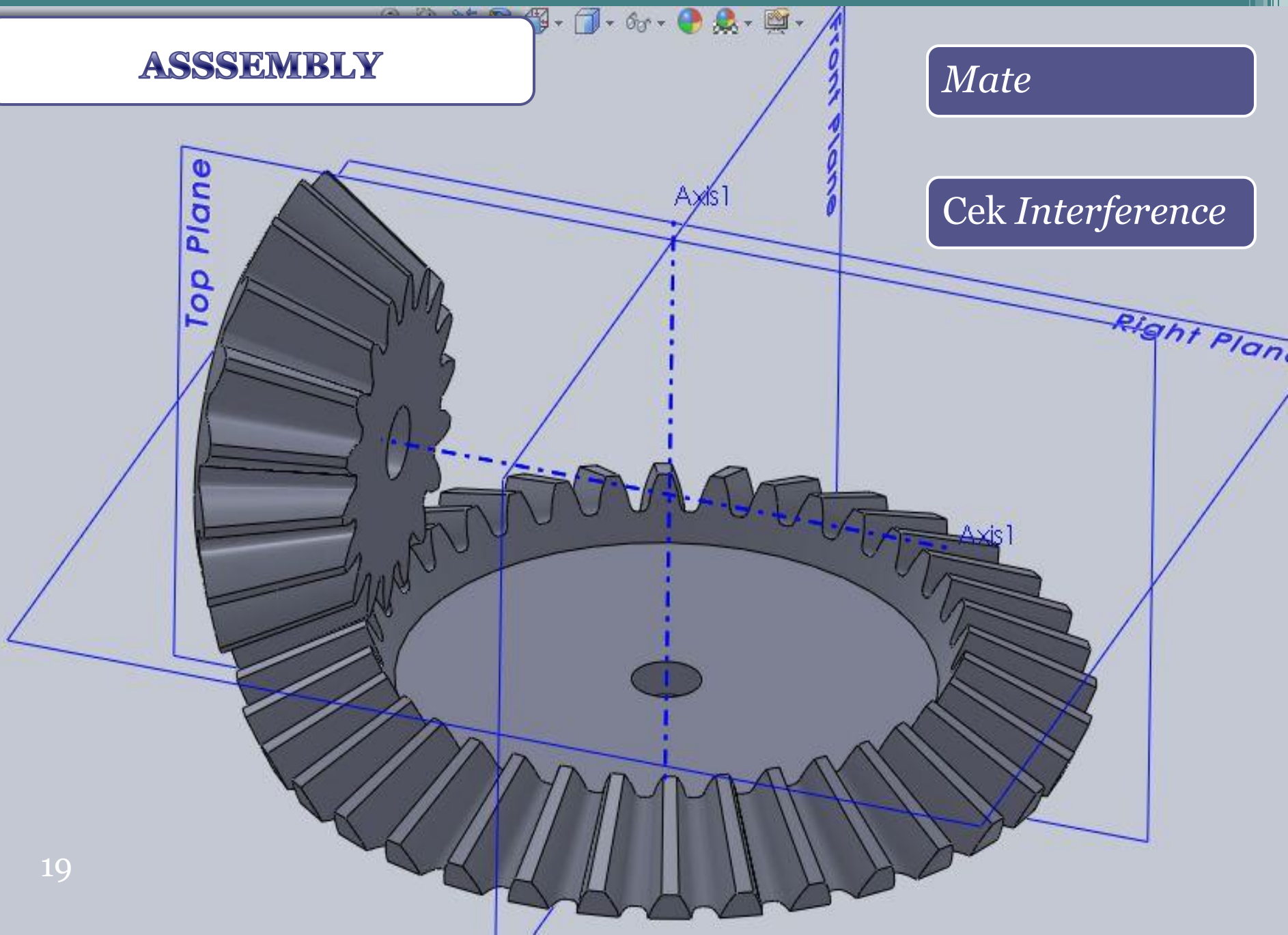
SKET GIGI GEAR



ASSSEMBLY

Mate

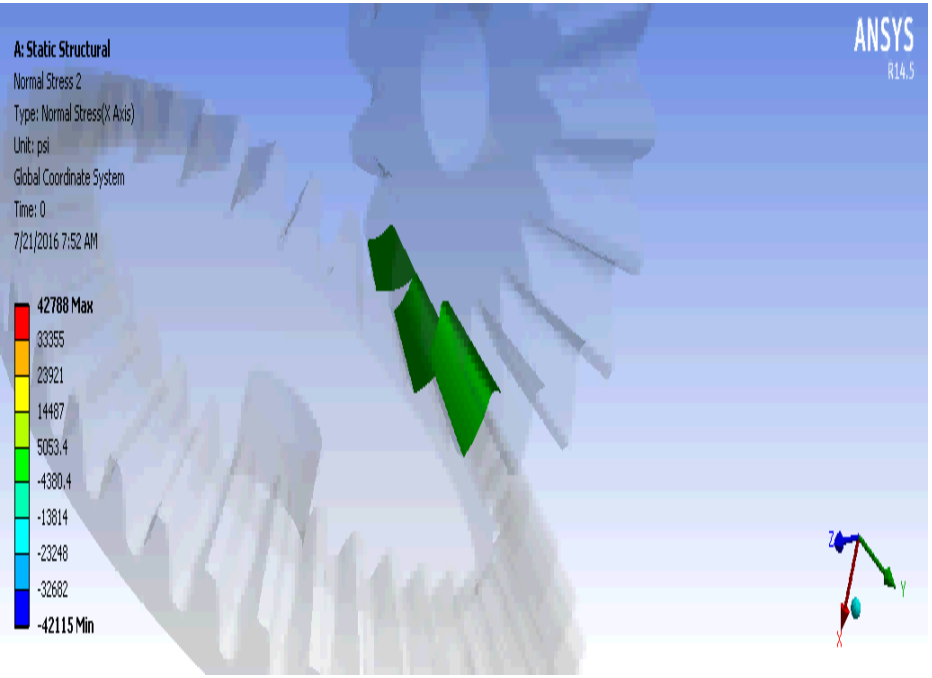
Cek *Interference*

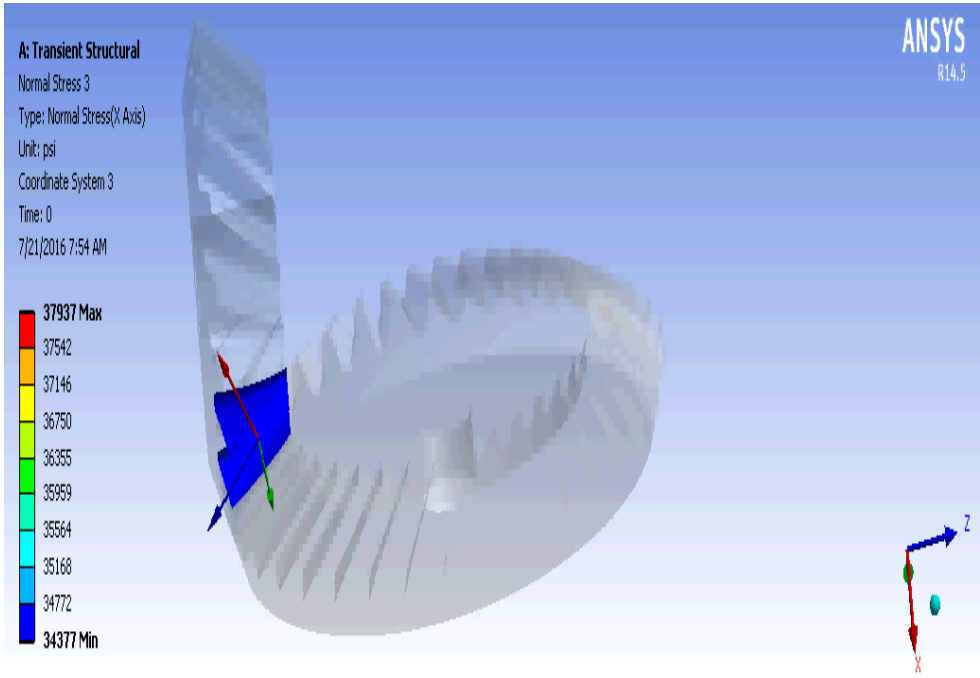


SIMULASI


A
1 Static Structural
2 Engineering Data
3 Geometry
4 Model
5 Setup
6 Solution
7 Results
Static Structural
B
1 Transient Structural
2 Engineering Data
3 Geometry
4 Model
5 Setup
6 Solution
7 Results
Transient Structural

Hasil Simulasi



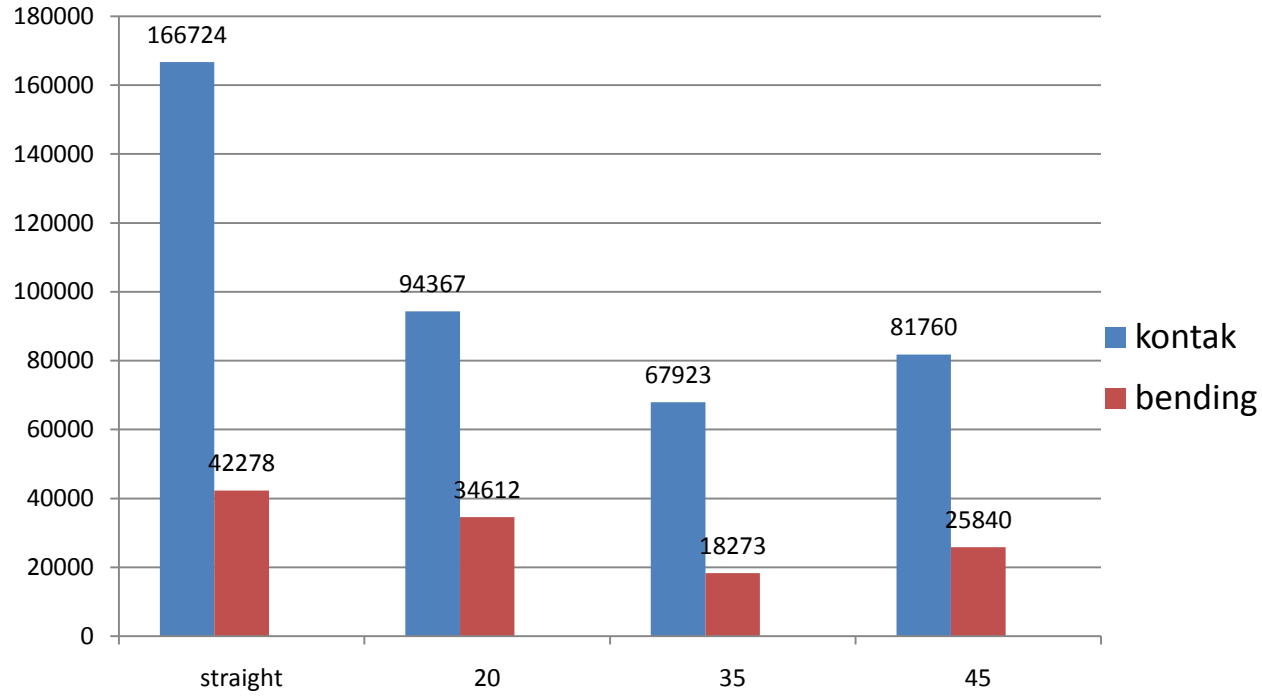


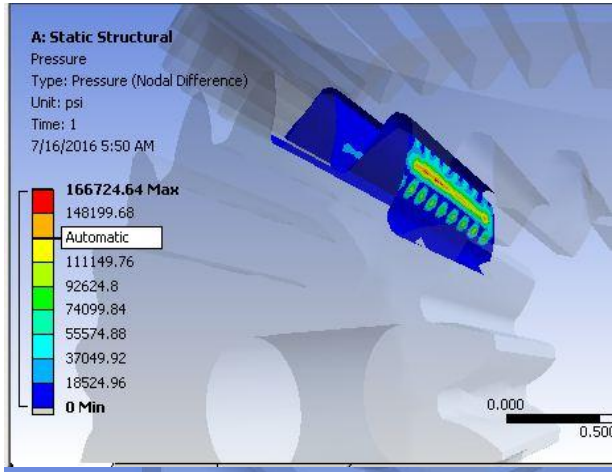
ANALISA DATA DAN PEMBAHASAN

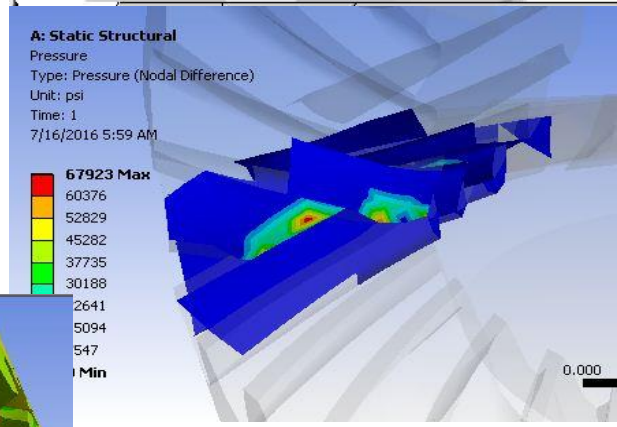
Perhitungan vs Simulasi Statis Straight Bevel Gear

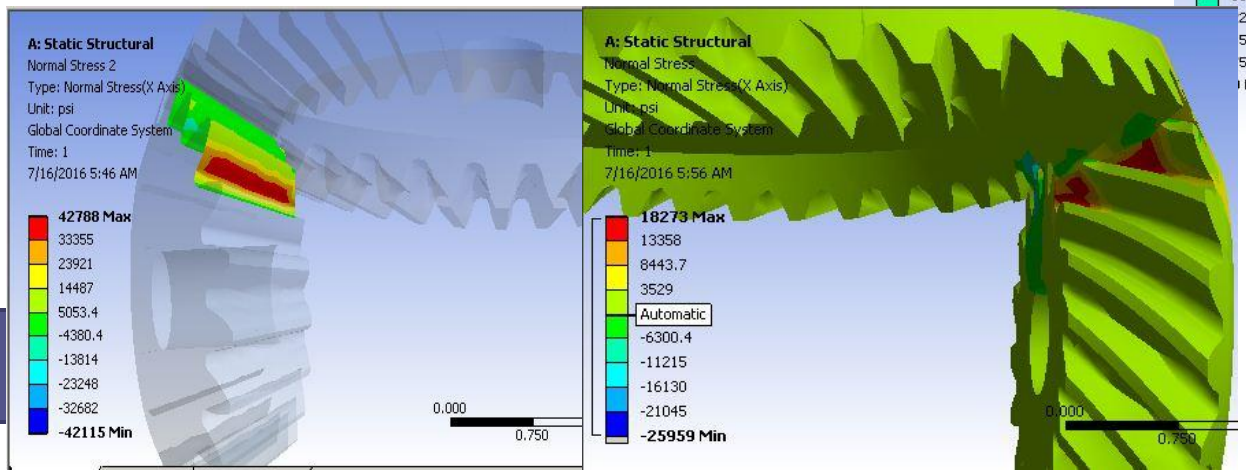
	Perhitungan	Simulasi	Selisih	Prosentase
Bending	37.793 psi	42.278	4.485	10 %
Kontak	140.072 psi	166.724	26652	15 %

HASIL SIMULASI STATIS

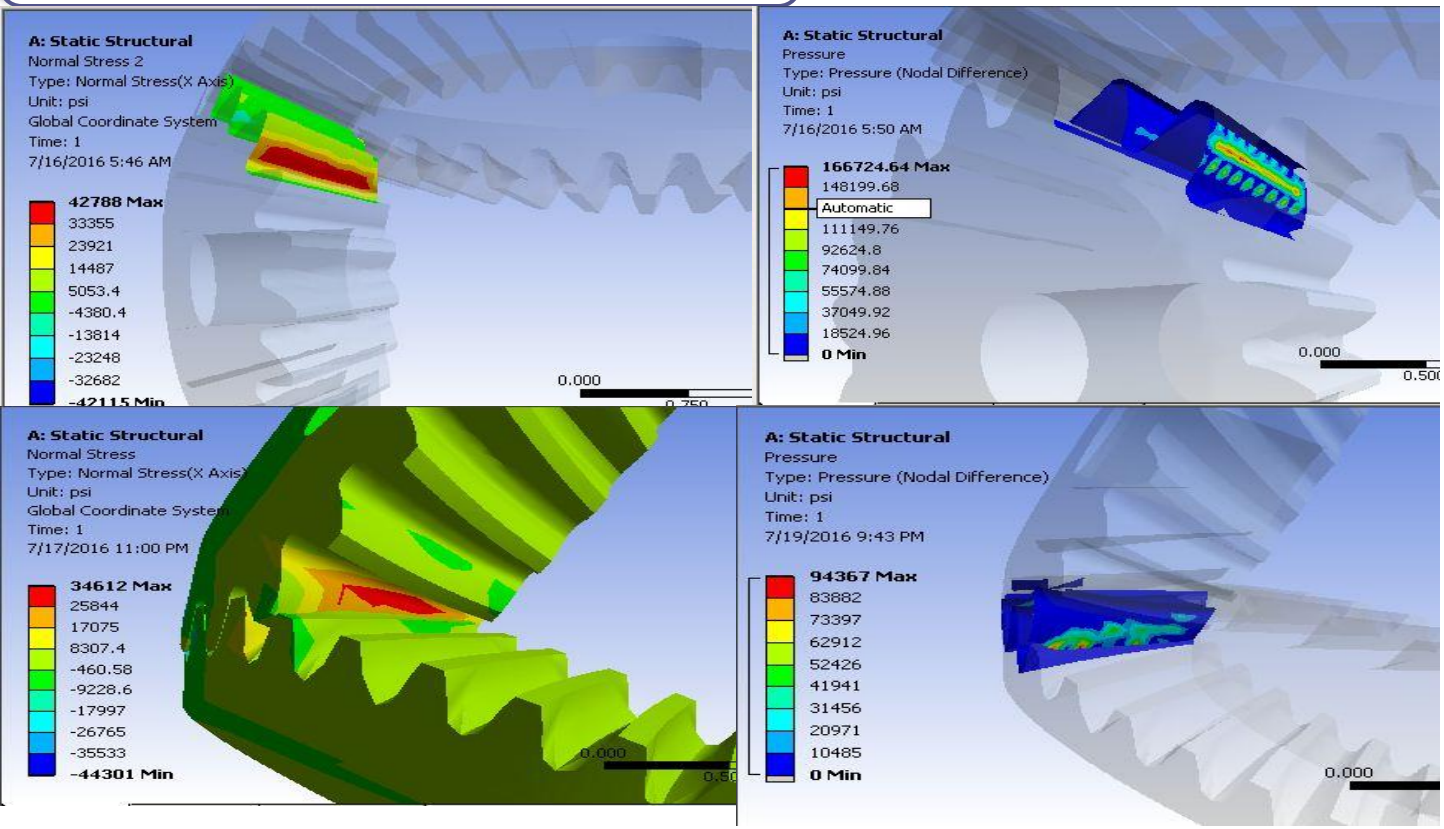




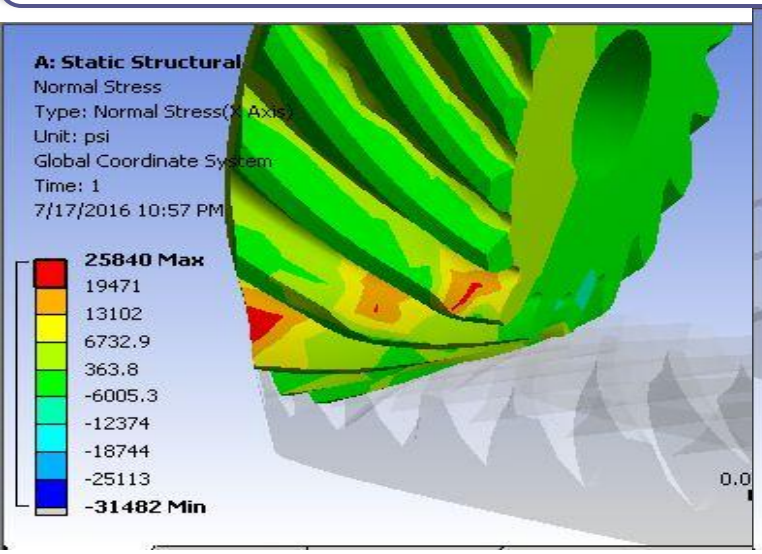


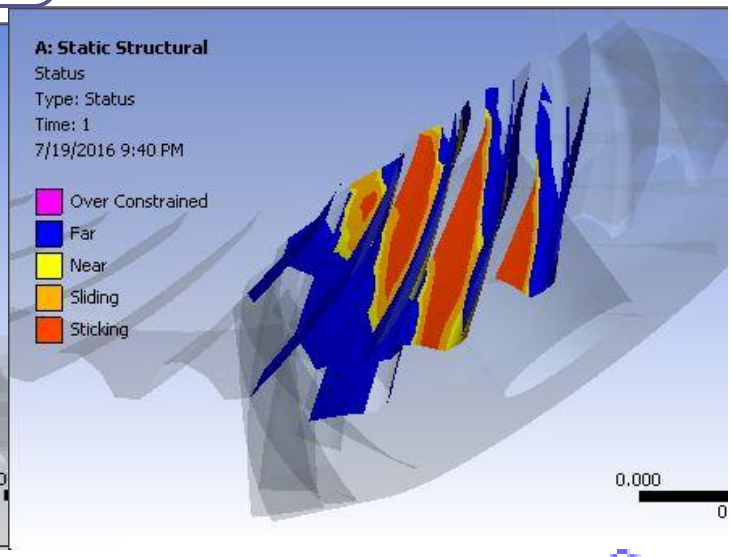


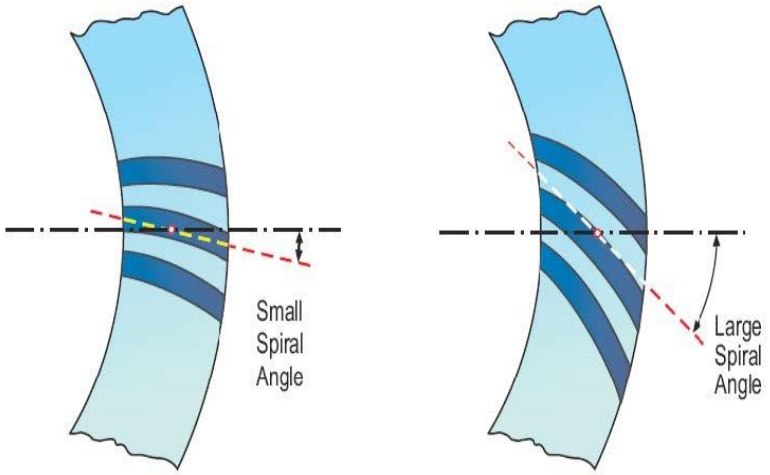
Sudut Spiral 20

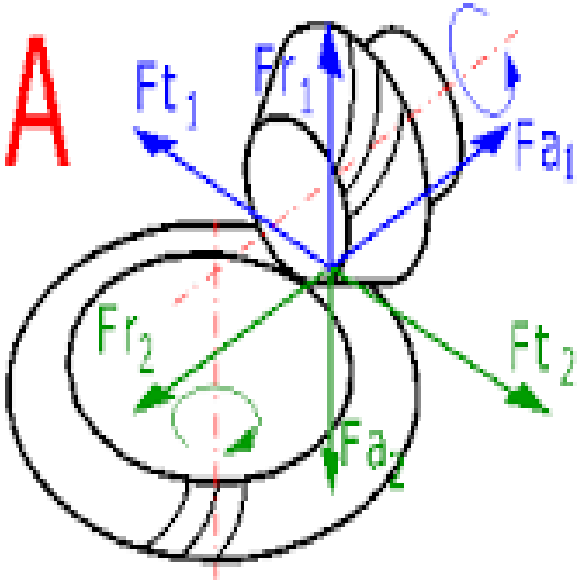


Sudut Spiral 45

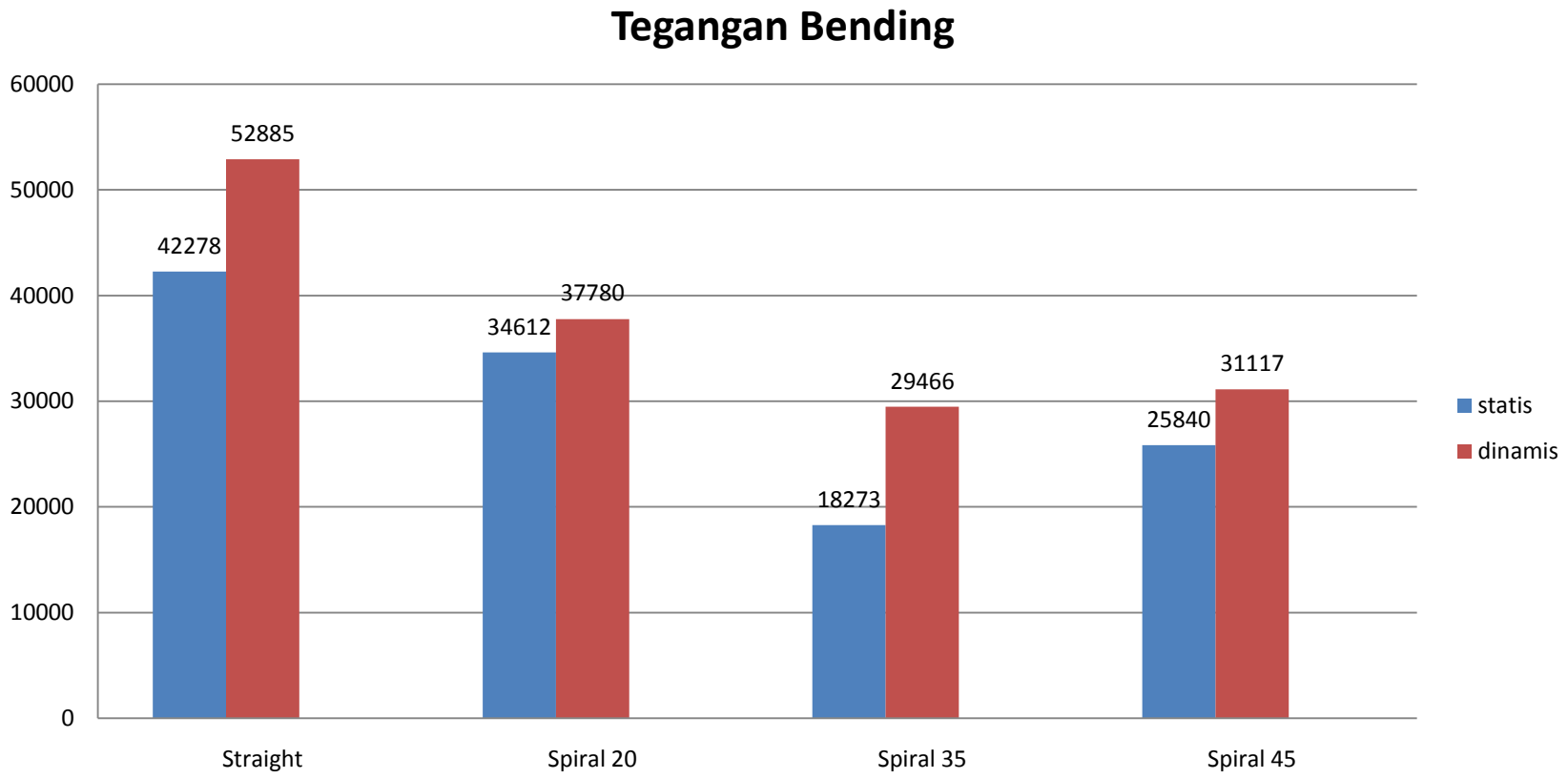








Dinamis Vs Statis

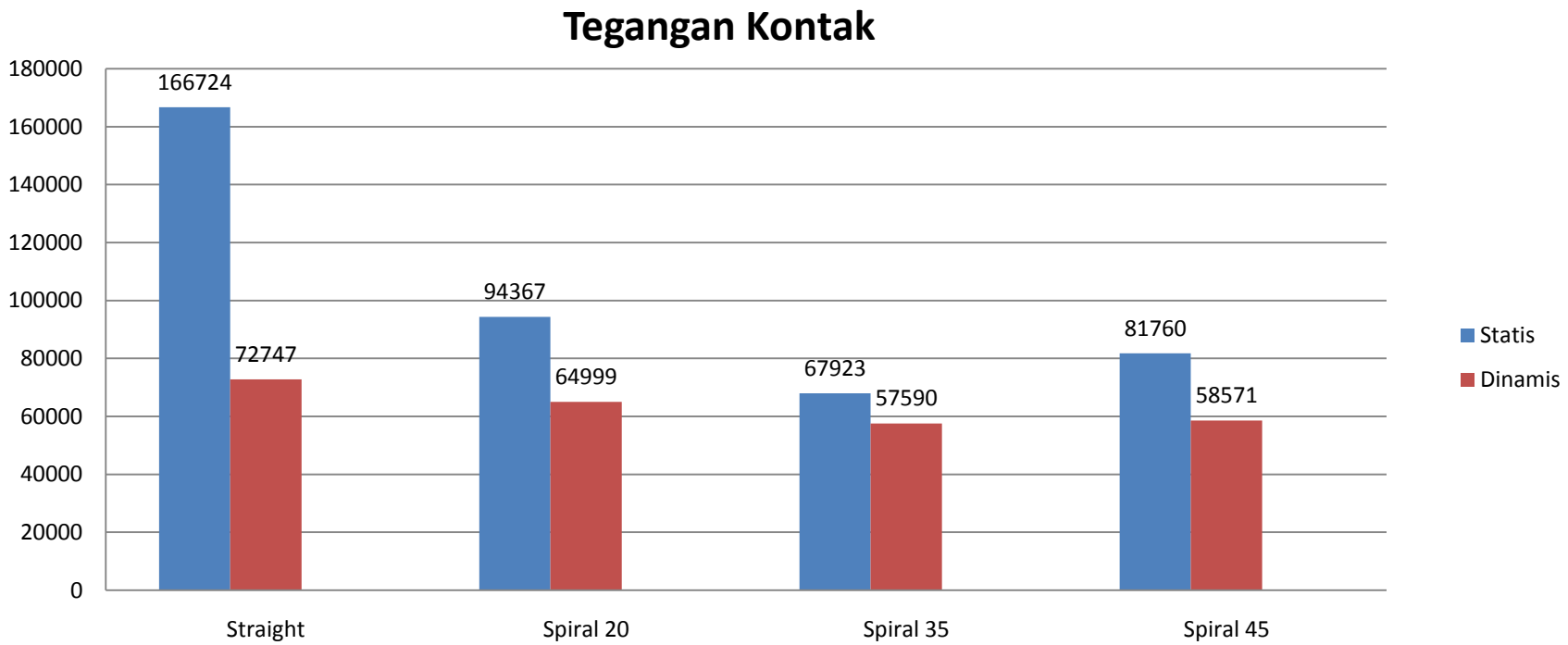


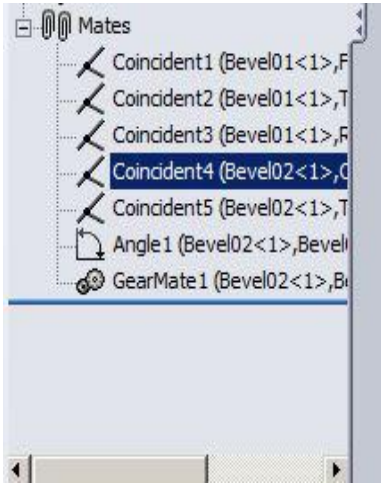
- Adanya beban kejut pada simulasi dinamis

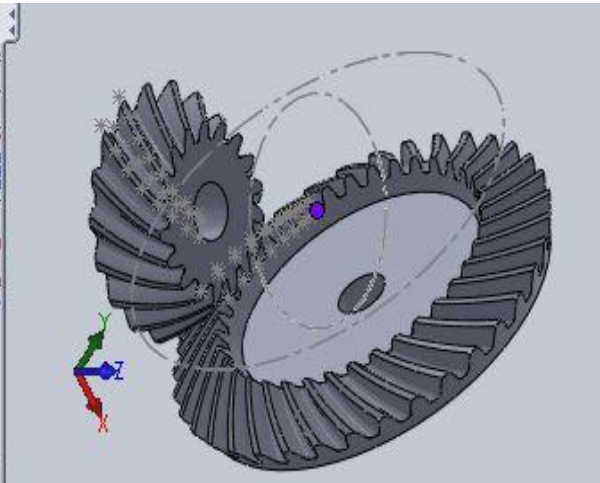
AGMA Bending Stress Equation

$$\sigma_t = \frac{W_t p_d K_a K_s K_m K_v K_i K_b}{b_w Y_j}$$

Dinamis Vs Statis







KESIMPULAN

- Proses desain straight bevel gear dan juga spiral bevel gear sudah cukup akurat.
- Nilai tegangan bending straight bevel gear pada simulasi dinamis 1,25 kali lebih besar daripada nilai tegangan simulasi statis, sedangkan tegangan kontaknya 2,29 lebih kecil.
- Secara keseluruhan spiral bevel gear lebih kuat daripada straight bevel gear pada dimensi dan beban yang sama jika dilihat dari lebih kecilnya tegangan bending dan tegangan kontak maksimum yang terjadi.
- Variasi sudut spiral 35 mempunyai nilai tegangan terkecil baik dari tegangan bending maupun tegangan kotaknya.
- Semakin besar sudut spiral tegangan yang terjadi semakin kecil karena semakin luasnya area kontak. Akan tetapi pada sudut spiral tertentu akan terjadi kenaikan tegangan dikarenakan gaya axial yang semakin besar.

SARAN

- Perlu adanya penelitian tentang perbandingan kekuatan spiral bevel gear ini dengan berbagai dimensi yang berbeda sehingga ada kemungkinan akan didapatkan koefisien sudut spiral.
- Untuk melakukan simulasi statis pada satu set gear, diperlukan ketelitian lebih pada proses asembly gear tersebut.

SEKIAN DAN TERIMA KASIH

Hubungan tegangan dan kekuatan/material