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LAMPIRAN

Data Uji Tarik Serat Tunggal Untread

NT1						NT2					NT3				
Time	Length	Area	Force	Stroke		Time	Length	Area	Force	Stroke	Length	Area	Time	Force	Stroke
sec	mm	mm2	N	mm		sec	mm	mm	N	mm	mm	mm2	sec	N	mm
0.000	25.000	0.020	0.002	0.000	0.000	0.000	25.000	0.031	-0.015	0.000	25.000	0.025	0.000	0.002	0.000
2.000	25.000	0.020	0.239	0.033	0.033	2.000	25.000	0.031	0.172	0.033	25.000	0.025	2.000	0.443	0.033
6.000	25.000	0.020	0.853	0.100	0.100	6.000	25.000	0.031	0.947	0.100	25.000	0.025	6.000	1.230	0.100
10.000	25.000	0.020	1.475	0.167	0.167	10.000	25.000	0.031	1.624	0.167	25.000	0.025	10.000	1.944	0.167
14.000	25.000	0.020	2.193	0.233	0.233	14.000	25.000	0.031	2.207	0.233	25.000	0.025	14.000	2.843	0.233
18.000	25.000	0.020	2.971	0.300	0.300	18.000	25.000	0.031	2.938	0.300	25.000	0.025	18.000	3.869	0.300
22.000	25.000	0.020	3.734	0.367	0.367	22.000	25.000	0.031	3.806	0.367	25.000	0.025	22.000	4.992	0.367
26.000	25.000	0.020	4.600	0.433	0.433	26.000	25.000	0.031	4.785	0.433	25.000	0.025	26.000	6.203	0.433
30.000	25.000	0.020	5.484	0.500	0.500	30.000	25.000	0.031	5.835	0.500	25.000	0.025	30.000	7.455	0.500
34.000	25.000	0.020	6.406	0.567	0.567	34.000	25.000	0.031	6.951	0.567	25.000	0.025	34.000	8.735	0.567
38.000	25.000	0.020	7.343	0.633	0.633	38.000	25.000	0.031	8.057	0.633	25.000	0.025	38.000	10.051	0.633
42.000	25.000	0.020	8.272	0.700	0.700	42.000	25.000	0.031	9.189	0.700	25.000	0.025	42.000	11.353	0.700
46.000	25.000	0.020	9.209	0.767	0.767	46.000	25.000	0.031	10.325	0.767	25.000	0.025	46.000	12.628	0.767
50.000	25.000	0.020	10.208	0.833	0.833	50.000	25.000	0.031	11.365	0.833	25.000	0.025	50.000	13.889	0.833
54.000	25.000	0.020	11.166	0.900	0.900	54.000	25.000	0.031	12.446	0.900	25.000	0.025	54.000	15.140	0.900
58.000	25.000	0.020	12.136	0.967	0.967	58.000	25.000	0.031	13.518	0.967	25.000	0.025	58.000	16.343	0.967
62.000	25.000	0.020	13.097	1.033	1.033	62.000	25.000	0.031	14.579	1.033	25.000	0.025	62.000	17.585	1.033
66.000	25.000	0.020	14.027	1.100	1.100	66.000	25.000	0.031	15.628	1.100	25.000	0.025	66.000	18.806	1.100
70.000	25.000	0.020	14.986	1.167	1.167	70.000	25.000	0.031	16.675	1.167	25.000	0.025	70.000	20.052	1.167
74.000	25.000	0.020	15.926	1.233	1.233	74.000	25.000	0.031	17.727	1.233	25.000	0.025	74.000	21.242	1.233
78.000	25.000	0.020	16.875	1.300	1.300	78.000	25.000	0.031	18.733	1.300	25.000	0.025	78.000	22.411	1.300
82.000	25.000	0.020	17.837	1.367	1.367	82.000	25.000	0.031	19.735	1.367	25.000	0.025	82.000	23.551	1.367
86.000	25.000	0.020	18.796	1.433	1.433	86.000	25.000	0.031	20.792	1.433	25.000	0.025	86.000	24.668	1.433
90.000	25.000	0.020	19.712	1.500	1.500	90.000	25.000	0.031	21.764	1.500	25.000	0.025	90.000	25.779	1.500
94.000	25.000	0.020	20.649	1.567	1.567	94.000	25.000	0.031	22.732	1.567	25.000	0.025		18.000	1.533
96.000	25.000	0.020	21.137	1.600	1.600		25.000	0.031	16.000	1.567	25.000	0.025			
100.000	25.000	0.020	22.065	1.667	1.667		25.000	0.031			25.000	0.025			
104.000	25.000	0.020	22.918	1.733	1.733		25.000	0.031			25.000	0.025			

Data Uji Tarik Serat Tunggal Tread

T1			T2			T3		
Strain	Stress	Modulus	Strain	Stress	Modulus	Strain	Stress	Modulus
mm/mm	N/mm2	N/mm2	mm/mm	N/mm2	N/mm2	mm/mm	N/mm2	N/mm2
-	-	0	0	0	0	0	0	0
0.13	11.90	8919	0.13	17.40	13027	0.13	17.40	13027
0.40	42.43	10605	0.40	48.37	12084	0.40	48.37	12084
0.67	73.40	11008	0.67	76.43	11460	0.67	76.43	11460
0.93	109.11	11689	0.93	111.77	11972	0.93	111.77	11972
1.20	147.86	12321	1.20	152.11	12673	1.20	152.11	12673
1.47	185.83	12669	1.47	196.29	13381	1.47	196.29	13381
1.73	228.90	13205	1.73	243.88	14068	1.73	243.88	14068
2.00	272.91	13645	2.00	293.09	14653	2.00	293.09	14653
2.27	318.75	14061	2.27	343.43	15150	2.27	343.43	15150
2.53	365.41	14423	2.53	395.18	15597	2.53	395.18	15597
2.80	411.64	14701	2.80	446.39	15941	2.80	446.39	15941
3.07	458.27	14943	3.07	496.51	16189	3.07	496.51	16189
3.33	507.98	15238	3.33	546.07	16381	3.33	546.07	16381
3.60	555.63	15434	3.60	595.25	16533	3.60	595.25	16533
3.87	603.92	15618	3.87	642.56	16617	3.87	642.56	16617
4.13	651.73	15767	4.13	691.40	16726	4.13	691.40	16726
4.40	698.00	15863	4.40	739.42	16804	4.40	739.42	16804
4.67	745.73	15979	4.67	788.39	16893	4.67	788.39	16893
4.93	792.47	16063	4.93	835.19	16929	4.93	835.19	16929
5.20	839.73	16148	5.20	881.16	16944	5.20	881.16	16944
5.47	887.58	16236	5.47	925.96	16938	5.47	925.96	16938
5.73	935.32	16313	5.73	969.87	16915	5.73	969.87	16915
6.00	980.91	16348	6.00	1013.58	16892	6.00	1013.58	16892
6.27	1,027.50	16396	6.13	707.71	11538	6.13	707.71	11538
6.40	1,051.82	16434						
6.67	1,097.97	16469						
6.93	1,140.41	16448						

Data Uji Tarik Serat Tunggal Treadment

T1				T2					T3				
Time	Force	Length	Area	Stroke	Kontrol	Time	Force	Area	Stroke	Time	Force	Area	Stroke
sec	N	mm	mm2	mm		sec	N	mm2	mm	sec	N	mm2	mm
-	0.01	25.00	0.01	0.00	0.00	-	(0.01)	0.01	0.00	-	0.05	0.01	-
4.00	0.70	25.00	0.01	0.06	0.06	4.00	0.14	0.01	0.07	4.00	0.50	0.01	0.07
8.00	0.90	25.00	0.01	0.13	0.13	8.00	0.55	0.01	0.13	8.00	1.11	0.01	0.13
12.00	1.80	25.00	0.01	0.20	0.20	12.00	0.91	0.01	0.20	12.00	1.63	0.01	0.20
16.00	2.61	25.00	0.01	0.27	0.27	16.00	1.33	0.01	0.27	16.00	2.18	0.01	0.27
20.00	3.30	25.00	0.01	0.33	0.33	20.00	1.73	0.01	0.33	20.00	2.69	0.01	0.33
24.00	3.94	25.00	0.01	0.40	0.40	24.00	2.12	0.01	0.40	24.00	3.29	0.01	0.40
28.00	4.63	25.00	0.01	0.47	0.47	28.00	2.56	0.01	0.47	28.00	3.90	0.01	0.47
32.00	5.34	25.00	0.01	0.53	0.53	32.00	3.05	0.01	0.53	32.00	4.52	0.01	0.53
36.00	6.05	25.00	0.01	0.60	0.60	36.00	3.57	0.01	0.60	36.00	5.14	0.01	0.60
40.00	6.77	25.00	0.01	0.67	0.67	40.00	4.12	0.01	0.67	40.00	5.86	0.01	0.67
44.00	7.51	25.00	0.01	0.73	0.73	44.00	4.71	0.01	0.73	44.00	6.52	0.01	0.73
48.00	8.21	25.00	0.01	0.80	0.80	48.00	5.29	0.01	0.80	48.00	7.26	0.01	0.80
52.00	8.96	25.00	0.01	0.87	0.87	52.00	5.93	0.01	0.87	52.00	7.87	0.01	0.87
56.00	9.68	25.00	0.01	0.93	0.93	56.00	6.55	0.01	0.93	56.00	8.57	0.01	0.93
60.00	10.42	25.00	0.01	1.00	1.00	60.00	7.18	0.01	1.00	60.00	9.32	0.01	1.00
64.00	11.13	25.00	0.01	1.07	1.07	64.00	7.85	0.01	1.07	64.00	9.93	0.01	1.07
68.00	11.86	25.00	0.01	1.13	1.13	68.00	8.49	0.01	1.13	68.00	10.59	0.01	1.13
72.00	12.58	25.00	0.01	1.20	1.20	72.00	9.12	0.01	1.20	72.00	11.21	0.01	1.20
76.00	13.24	25.00	0.01	1.27	1.27	76.00	9.74	0.01	1.27	76.00	11.82	0.01	1.27
80.00	13.92	25.00	0.01	1.33	1.33	80.00	10.37	0.01	1.33	80.00	12.39	0.01	1.33
84.00	14.53	25.00	0.01	1.40	1.40	84.00	10.99	0.01	1.40	84.00	12.97	0.01	1.40
88.00	15.14	25.00	0.01	1.47	1.47	88.00	11.58	0.01	1.47	88.00	13.52	0.01	1.47
92.00	15.73	25.00	0.01	1.53	1.53	92.00	12.20	0.01	1.53	92.00	14.10	0.01	1.53
96.00	16.37	25.00	0.01	1.60	1.60	96.00	12.73	0.01	1.60	96.00	14.68	0.01	1.60
100.00	16.95	25.00	0.01	1.67	1.67	100.00	13.31	0.01	1.67	100.00	15.28	0.01	1.67
104.00	17.55	25.00	0.01	1.73	1.73	104.00	13.83	0.01	1.73	104.00	15.85	0.01	1.73
108.00	18.14	25.00	0.01	1.80	1.80	108.00	14.38	0.01	1.80	108.00	16.40	0.01	1.80
112.00	18.69	25.00	0.01	1.87	1.87	112.00	14.92	0.01	1.87	112.00	16.90	0.01	1.87
116.00	19.32	25.00	0.01	1.93	1.93	116.00	15.50	0.01	1.93	116.00	17.39	0.01	1.93
120.00	19.75	25.00	0.01	2.00	2.00	120.00	16.04	0.01	2.00	120.00	17.89	0.01	2.00
124.00	20.12	25.00	0.01	2.07	2.07	124.00	16.64	0.01	2.07	124.00	18.35	0.01	2.07
128.00	20.58	25.00	0.01	2.13	2.13	128.00	17.07	0.01	2.13	128.00	18.86	0.01	2.13
132.00	21.08	25.00	0.01	2.20	2.20	132.00	17.65	0.01	2.20	132.00	19.36	0.01	2.20
136.00	17.02	25.00	0.01	2.27	2.27	136.00	18.22	0.01	2.27	136.00	19.84	0.01	2.27
140.00	18.58	25.00	0.01	2.33	2.33	140.00	18.74	0.01	2.33	140.00	20.25	0.01	2.33
144.00	17.74	25.00	0.01	2.40	2.40	144.00	19.27	0.01	2.40	144.00	20.69	0.01	2.40
148.00	16.95	25.00	0.01	2.47	2.47	148.00	19.80	0.01	2.47	148.00	21.08	0.01	2.47
152.00	16.86	25.00	0.01	2.53	2.53	152.00	20.39	0.01	2.53	152.00	21.39	0.01	2.53
156.00	18.15	25.00	0.01	2.60	2.60	156.00	20.90	0.01	2.60	156.00	21.70	0.01	2.60
160.00	17.83	25.00	0.01	2.67	2.67	160.00	21.47	0.01	2.67	160.00	22.09	0.01	2.67
164.00	17.00	25.00	0.01	2.73	2.73	164.00	21.98	0.01	2.73	164.00	22.09	0.01	2.73
168.00	18.52	25.00	0.01	2.80	2.80	168.00	22.51	0.01	2.80	168.00	21.33	0.01	2.80
172.00	12.31	25.00	0.01	2.87	2.87	172.00	23.03	0.01	2.87	172.00	20.34	0.01	2.87
176.00	9.99	25.00	0.01	2.93	2.93	176.00	23.56	0.01	2.93	176.00	19.56	0.01	2.93
	-	25.00	0.01	2.93	2.93		16.00	0.01	2.93	180.00	19.10	0.01	3.00
		25.00	0.01					0.01		184.00	18.93	0.01	3.07
		25.00	0.01					0.01		188.00	18.96	0.01	3.13
		25.00	0.01					0.01		192.00	18.98	0.01	3.20
		25.00	0.01					0.01		196.00	19.13	0.01	3.27
		25.00	0.01					0.01		200.00	19.40	0.01	3.33
		25.00	0.01					0.01		204.00	19.57	0.01	3.40
		25.00	0.01					0.01		208.00	19.91	0.01	3.47
		25.00	0.01					0.01		212.00	20.20	0.01	3.53
		25.00	0.01					0.01		216.00	20.48	0.01	3.60
		25.00	0.01					0.01		220.00	20.79	0.01	3.67
		25.00	0.01					0.01		224.00	20.96	0.01	3.73
		25.00	0.01					0.01		228.00	21.28	0.01	3.80
		25.00	0.01					0.01		232.00	21.55	0.01	3.87
		25.00	0.01					0.01		236.00	21.86	0.01	3.93
		25.00	0.01					0.01		240.00	22.07	0.01	4.00
		25.00	0.01					0.01		244.00	22.22	0.01	4.07
		25.00	0.01					0.01		248.00	22.21	0.01	4.13
		25.00	0.01					0.01		252.00	22.05	0.01	4.20
		25.00	0.01					0.01		256.00	21.72	0.01	4.27
		25.00	0.01					0.01		260.00	21.17	0.01	4.33
		25.00	0.01					0.01		264.00	10.49	0.01	4.40
		25.00	0.01					0.01		268.00	11.10	0.01	4.47
		25.00	0.01					0.01		272.00	10.35	0.01	4.53
		25.00	0.01					0.01		276.00	10.61	0.01	4.60
		25.00	0.01					0.01		280.00	10.40	0.01	4.67
		25.00	0.01					0.01		284.00	10.32	0.01	4.73
		25.00	0.01					0.01		288.00	10.42	0.01	4.80
		25.00	0.01					0.01		292.00	10.24	0.01	4.87
		25.00	0.01					0.01			-	0.01	4.87

Data Uji Tarik Serat Tunggal Treadment

T1			T2			T3		
Strain	Stress	Modulus	Strain	Stress	Modulus	Strain	Stress	Modulus
mm/mm	N/mm2	N/mm2	mm/mm	N/mm2	N/mm2	mm/mm	N/mm2	N/mm2
-	-	-	-	-	-	-	-	-
0.00	61.92	0	0.27	12.09	4530	0.27	44.08	16522
0.52	79.62	15311	0.53	48.58	9104	0.53	98.57	18481
0.80	159.24	19898	0.80	80.22	10024	0.80	144.34	18039
1.07	230.89	21641	1.07	117.48	11011	1.07	192.64	18057
1.33	291.84	21883	1.33	153.41	11504	1.33	237.98	17849
1.60	348.92	21804	1.60	187.86	11739	1.60	291.27	18203
1.87	409.67	21943	1.87	226.31	12122	1.87	344.99	18481
2.13	472.03	22124	2.13	269.55	12634	2.13	399.82	18741
2.40	535.51	22311	2.40	315.74	13154	2.40	454.87	18953
2.67	598.72	22450	2.67	364.04	13650	2.67	518.15	19431
2.93	664.03	22635	2.93	416.98	14214	2.93	576.64	19658
3.20	726.11	22689	3.20	467.81	14618	3.20	642.66	20083
3.47	793.04	22874	3.47	524.34	15124	3.47	696.37	20087
3.73	856.39	22937	3.73	579.88	15531	3.73	757.89	20300
4.00	922.12	23051	4.00	635.00	15874	4.00	824.05	20601
4.27	985.04	23086	4.27	694.61	16279	4.27	878.60	20592
4.53	1,049.09	23140	4.53	750.65	16557	4.53	936.46	20657
4.80	1,112.51	23176	4.80	807.03	16812	4.80	991.72	20660
5.07	1,170.86	23108	5.07	861.66	17006	5.07	1,045.58	20636
5.33	1,231.04	23081	5.33	917.48	17202	5.33	1,096.06	20551
5.60	1,285.32	22951	5.60	972.32	17362	5.60	1,147.38	20489
5.87	1,338.96	22822	5.87	1,024.63	17464	5.87	1,196.45	20394
6.13	1,391.90	22693	6.13	1,079.11	17594	6.13	1,247.56	20340
6.40	1,447.72	22620	6.40	1,126.08	17594	6.40	1,298.89	20295
6.67	1,499.75	22495	6.67	1,177.82	17667	6.67	1,351.76	20276
6.93	1,552.41	22390	6.93	1,223.38	17644	6.93	1,401.88	20219
7.20	1,604.50	22284	7.20	1,272.24	17670	7.20	1,451.03	20153
7.47	1,653.44	22143	7.47	1,319.84	17676	7.47	1,494.90	20021
7.73	1,708.77	22095	7.73	1,371.37	17733	7.73	1,537.99	19888
8.00	1,747.36	21841	8.00	1,419.25	17740	8.00	1,582.85	19785
8.27	1,780.34	21536	8.27	1,471.77	17803	8.27	1,623.70	19641
8.53	1,820.97	21339	8.53	1,510.08	17696	8.53	1,668.41	19551
8.80	1,864.56	21188	8.80	1,561.19	17740	8.80	1,712.91	19465
9.07	1,505.94	16609	9.07	1,611.46	17773	9.07	1,754.74	19354
9.33	1,644.01	17614	9.33	1,657.44	17758	9.33	1,791.23	19191
9.60	1,569.56	16349	9.60	1,704.55	17755	9.60	1,830.60	19069
9.87	1,499.61	15198	9.87	1,751.16	17748	9.87	1,864.77	18900
10.13	1,491.66	14720	10.13	1,803.68	17799	10.13	1,892.54	18676
10.40	1,605.49	15437	10.40	1,848.95	17778	10.40	1,919.89	18460
10.67	1,577.08	14785	10.67	1,899.64	17809	10.67	1,954.20	18321
10.93	1,503.76	13754	10.93	1,944.64	17786	10.93	1,953.92	17871
11.20	1,638.67	14631	11.20	1,991.60	17782	11.20	1,887.27	16851
11.47	1,089.38	9500	11.47	2,037.44	17768	11.47	1,799.04	15689
11.73	883.81	7532	11.73	2,084.12	17762	11.73	1,730.63	14750
11.73	-	-	11.73	1,415.43	12063	12.00	1,689.57	14080
-	-					12.27	1,674.81	13653
-	-					12.53	1,677.13	13381
-	-					12.80	1,678.74	13115
-	-					13.07	1,692.31	12951
-	-					13.33	1,716.64	12875
-	-					13.60	1,731.54	12732
-	-					13.87	1,761.42	12703
-	-					14.13	1,786.80	12642
-	-					14.40	1,811.55	12580
-	-					14.67	1,838.76	12537
-	-					14.93	1,853.94	12415
-	-					15.20	1,882.35	12384
-	-					15.47	1,906.18	12324
-	-					15.73	1,933.60	12290
-	-					16.00	1,952.23	12201
-	-					16.27	1,965.45	12083
-	-					16.53	1,965.03	11885
-	-					16.80	1,950.40	11610
-	-					17.07	1,921.58	11259
-	-					17.33	1,872.44	10803
-	-					17.60	927.61	5270
-	-					17.87	982.23	5498
-	-					18.13	916.00	5051
-	-					18.40	938.29	5099
-	-					18.67	920.29	4930
-	-					18.93	912.98	4822
-	-					19.20	921.91	4802
-	-					19.47	905.46	4651
-	-					0.19	-	-

Data Uji Tarik AFS A2

Time	Load	Elong	Area	Length	Disp	Dis Kontrol	Stress	Strain	Width	Strain	Strength	Modulus
0.00	0.00	0.00	76.80	250.00	0.000	0.000	0.00	0.00	0.00	0.000	0.00	0
1.98	0.00	0.00	76.80	250.00	0.000	0.000	0.00	0.00	0.00	0.000	0.00	0
3.98	0.00	0.00	76.80	250.00	0.000	0.000	0.00	0.00	0.00	0.000	0.00	0
5.98	0.35	-0.02	76.80	250.00	0.106	0.106	3.50	-0.03	0.00	0.042	4.56	10748
7.97	0.50	0.07	76.80	250.00	0.195	0.195	5.00	0.15	0.00	0.078	6.51	8347
9.97	0.65	0.15	76.80	250.00	0.268	0.268	6.50	0.29	0.00	0.107	8.46	7895
11.97	0.80	0.21	76.80	250.00	0.333	0.333	8.00	0.42	0.00	0.133	10.42	7820
13.97	0.90	0.28	76.80	250.00	0.406	0.406	9.00	0.57	0.00	0.162	11.72	7216
15.97	1.00	0.35	76.80	250.00	0.471	0.471	10.00	0.70	0.00	0.188	13.02	6911
17.96	1.15	0.41	76.80	250.00	0.536	0.536	11.50	0.83	0.00	0.214	14.97	6984
19.96	1.25	0.48	76.80	250.00	0.601	0.601	12.50	0.96	0.00	0.240	16.28	6770
21.96	1.35	0.54	76.80	250.00	0.666	0.666	13.50	1.09	0.00	0.266	17.58	6598
23.96	1.45	0.62	76.80	250.00	0.739	0.739	14.50	1.23	0.00	0.296	18.88	6387
25.96	1.60	0.68	76.80	250.00	0.804	0.804	16.00	1.36	0.00	0.322	20.83	6478
27.95	1.70	0.75	76.80	250.00	0.869	0.869	17.00	1.49	0.00	0.348	22.14	6368
29.95	1.80	0.81	76.80	250.00	0.933	0.933	18.00	1.62	0.00	0.373	23.44	6280
31.95	1.90	0.88	76.80	250.00	0.998	0.998	19.00	1.75	0.00	0.399	24.74	6197
33.95	2.00	0.95	76.80	250.00	1.071	1.071	20.00	1.90	0.00	0.428	26.04	6079
35.95	2.10	1.02	76.80	250.00	1.136	1.136	21.00	2.03	0.00	0.454	27.34	6018
37.94	2.20	1.08	76.80	250.00	1.201	1.201	22.00	2.16	0.00	0.480	28.65	5963
39.94	2.35	1.14	76.80	250.00	1.266	1.266	23.50	2.29	0.00	0.506	30.60	6042
41.94	2.45	1.21	76.80	250.00	1.331	1.331	24.50	2.42	0.00	0.532	31.90	5992
43.94	2.55	1.28	76.80	250.00	1.404	1.404	25.50	2.56	0.00	0.562	33.20	5912
45.94	2.65	1.35	76.80	250.00	1.469	1.469	26.50	2.69	0.00	0.588	34.51	5872
47.93	2.75	1.41	76.80	250.00	1.534	1.534	27.50	2.82	0.00	0.614	35.81	5836
49.93	2.85	1.48	76.80	250.00	1.599	1.599	28.50	2.95	0.00	0.640	37.11	5802
51.93	2.95	1.54	76.80	250.00	1.664	1.664	29.50	3.08	0.00	0.666	38.41	5771
53.93	3.05	1.62	76.80	250.00	1.737	1.737	30.50	3.23	0.00	0.695	39.71	5716
55.93	3.20	1.68	76.80	250.00	1.802	1.802	32.00	3.36	0.00	0.721	41.67	5781
57.92	3.30	1.75	76.80	250.00	1.867	1.867	33.00	3.49	0.00	0.747	42.97	5754
59.92	3.40	1.81	76.80	250.00	1.932	1.932	34.00	3.62	0.00	0.773	44.27	5729
61.92	3.50	1.88	76.80	250.00	1.997	1.997	35.00	3.75	0.00	0.799	45.57	5705
63.92	3.55	1.95	76.80	250.00	2.070	2.070	35.50	3.90	0.00	0.828	46.22	5583
65.92	3.65	2.01	76.80	250.00	2.135	2.135	36.50	4.03	0.00	0.854	47.53	5565
67.92	3.75	2.08	76.80	250.00	2.200	2.200	37.50	4.16	0.00	0.880	48.83	5549
69.91	3.85	2.14	76.80	250.00	2.265	2.265	38.50	4.29	0.00	0.906	50.13	5533
71.91	3.90	2.21	76.80	250.00	2.330	2.330	39.00	4.42	0.00	0.932	50.78	5449
73.91	4.00	2.28	76.80	250.00	2.403	2.403	40.00	4.56	0.00	0.961	52.08	5419
75.91	4.05	2.35	76.80	250.00	2.468	2.468	40.50	4.69	0.00	0.987	52.73	5342
77.91	4.15	2.41	76.80	250.00	2.532	2.532	41.50	4.82	0.00	1.013	54.04	5335
79.90	4.20	2.48	76.80	250.00	2.597	2.597	42.00	4.95	0.00	1.039	54.69	5264
81.90	4.30	2.54	76.80	250.00	2.662	2.662	43.00	5.08	0.00	1.065	55.99	5258
83.90	4.40	2.61	76.80	250.00	2.735	2.735	44.00	5.23	0.00	1.094	57.29	5237
85.90	4.50	2.68	76.80	250.00	2.800	2.800	45.00	5.36	0.00	1.120	58.59	5232
87.90	4.65	2.74	76.80	250.00	2.865	2.865	46.50	5.49	0.00	1.146	60.55	5283
89.89	4.75	2.81	76.80	250.00	2.930	2.930	47.50	5.62	0.00	1.172	61.85	5277
91.89	4.85	2.88	76.80	250.00	3.003	3.003	48.50	5.76	0.00	1.201	63.15	5257
93.89	4.95	2.95	76.80	250.00	3.068	3.068	49.50	5.89	0.00	1.227	64.45	5252
95.89	5.05	3.01	76.80	250.00	3.133	3.133	50.50	6.02	0.00	1.253	65.76	5247
97.89	5.10	3.08	76.80	250.00	3.198	3.198	51.00	6.15	0.00	1.279	66.41	5191
99.88	5.20	3.14	76.80	250.00	3.263	3.263	52.00	6.28	0.00	1.305	67.71	5188
101.88	5.30	3.21	76.80	250.00	3.336	3.336	53.00	6.43	0.00	1.334	69.01	5172
103.88	5.40	3.28	76.80	250.00	3.401	3.401	54.00	6.56	0.00	1.360	70.31	5169
105.88	5.50	3.34	76.80	250.00	3.466	3.466	55.00	6.69	0.00	1.386	71.61	5166
107.88	5.50	3.41	76.80	250.00	3.531	3.531	55.00	6.82	0.00	1.412	71.61	5070
109.87	5.55	3.47	76.80	250.00	3.596	3.596	55.50	6.95	0.00	1.438	72.27	5024
111.87	5.55	3.55	76.80	250.00	3.669	3.669	55.50	7.09	0.00	1.468	72.27	4924
113.87	5.65	3.61	76.80	250.00	3.734	3.734	56.50	7.22	0.00	1.494	73.57	4926
115.87	5.70	3.68	76.80	250.00	3.799	3.799	57.00	7.35	0.00	1.520	74.22	4884
117.87	5.75	3.74	76.80	250.00	3.864	3.864	57.50	7.48	0.00	1.546	74.87	4844
119.86	5.80	3.81	76.80	250.00	3.929	3.929	58.00	7.61	0.00	1.572	75.52	4805
121.86	5.90	3.88	76.80	250.00	4.002	4.002	59.00	7.76	0.00	1.601	76.82	4799
123.86	6.00	3.95	76.80	250.00	4.067	4.067	60.00	7.89	0.00	1.627	78.13	4802
125.86	0.50	4.01	76.80	250.00	4.131	4.131	-0.50	8.02	0.00	1.652	6.51	394
127.86	0.50	4.08	76.80	250.00	4.196	4.196	-0.50	8.15	0.00	1.678	6.51	388

Data Uji Tarik AFS A3

Time	Load	Elong	Area	Length	Disp	Disp Kontrol	Stress	Strain	Width	Strain	Strength	Modulus
0.0000	0.0000	0.0000	88.2000	250.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.00	0.00
1.9790	0.0000	0.0000	88.2000	250.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.00	0.00
3.9770	0.0000	0.0000	88.2000	250.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.00	0.00
5.9750	0.5500	-0.0160	88.2000	250.00	0.0970	0.0970	5.5000	-0.0320	0.0000	0.04	6.24	161
7.9740	0.7500	0.0730	88.2000	250.00	0.1870	0.1870	7.5000	0.1460	0.0000	0.07	8.50	114
9.9710	0.9000	0.1460	88.2000	250.00	0.2600	0.2600	9.0000	0.2920	0.0000	0.10	10.20	9812
11.9690	1.0500	0.2110	88.2000	250.00	0.3250	0.3250	10.5000	0.4220	0.0000	0.13	11.90	9158
13.9670	1.1500	0.2760	88.2000	250.00	0.3900	0.3900	11.5000	0.5520	0.0000	0.16	13.04	8358
15.9650	1.3000	0.3490	88.2000	250.00	0.4630	0.4630	13.0000	0.6980	0.0000	0.19	14.74	7959
17.9630	1.4000	0.4140	88.2000	250.00	0.5280	0.5280	14.0000	0.8280	0.0000	0.21	15.87	7516
19.9610	1.5500	0.4790	88.2000	250.00	0.5930	0.5930	15.5000	0.9580	0.0000	0.24	17.57	7409
21.9590	1.6500	0.5440	88.2000	250.00	0.6570	0.6570	16.5000	1.0880	0.0000	0.26	18.71	7119
23.9570	1.8000	0.6090	88.2000	250.00	0.7220	0.7220	18.0000	1.2180	0.0000	0.29	20.41	7067
25.9550	1.9000	0.6820	88.2000	250.00	0.7950	0.7950	19.0000	1.3640	0.0000	0.32	21.54	6774
27.9530	2.0500	0.7470	88.2000	250.00	0.8600	0.8600	20.5000	1.4940	0.0000	0.34	23.24	6757
29.9510	2.1500	0.8120	88.2000	250.00	0.9250	0.9250	21.5000	1.6240	0.0000	0.37	24.38	6588
31.9490	2.3000	0.8770	88.2000	250.00	0.9900	0.9900	23.0000	1.7540	0.0000	0.40	26.08	6585
33.9470	2.4000	0.9420	88.2000	250.00	1.0550	1.0550	24.0000	1.8840	0.0000	0.42	27.21	6448
35.9460	2.5500	1.0150	88.2000	250.00	1.1280	1.1280	25.5000	2.0300	0.0000	0.45	28.91	6408
37.9440	2.6500	1.0800	88.2000	250.00	1.1930	1.1930	26.5000	2.1600	0.0000	0.48	30.05	6296
39.9420	2.8000	1.1440	88.2000	250.00	1.2580	1.2580	28.0000	2.2880	0.0000	0.50	31.75	6309
41.9400	2.9000	1.2090	88.2000	250.00	1.3230	1.3230	29.0000	2.4180	0.0000	0.53	32.88	6213
43.9380	3.0000	1.2740	88.2000	250.00	1.3880	1.3880	30.0000	2.5480	0.0000	0.56	34.01	6126
45.9360	3.1500	1.3470	88.2000	250.00	1.4610	1.4610	31.5000	2.6940	0.0000	0.58	35.71	6111
47.9340	3.2500	1.4120	88.2000	250.00	1.5260	1.5260	32.5000	2.8240	0.0000	0.61	36.85	6037
49.9320	3.3500	1.4770	88.2000	250.00	1.5910	1.5910	33.5000	2.9540	0.0000	0.64	37.98	5968
51.9300	3.5000	1.5420	88.2000	250.00	1.6560	1.6560	35.0000	3.0840	0.0000	0.66	39.68	5991
53.9280	3.6000	1.6070	88.2000	250.00	1.7210	1.7210	36.0000	3.2140	0.0000	0.69	40.82	5929
55.9260	3.7000	1.6800	88.2000	250.00	1.7940	1.7940	37.0000	3.3600	0.0000	0.72	41.95	5846
57.9240	3.8000	1.7450	88.2000	250.00	1.8590	1.8590	38.0000	3.4900	0.0000	0.74	43.08	5794
59.9230	3.9000	1.8100	88.2000	250.00	1.9240	1.9240	39.0000	3.6200	0.0000	0.77	44.22	5746
61.9200	3.9000	1.8750	88.2000	250.00	1.9890	1.9890	39.0000	3.7500	0.0000	0.80	44.22	5558
63.9180	4.0000	1.9400	88.2000	250.00	2.0540	2.0540	40.0000	3.8800	0.0000	0.82	45.35	5520
65.9160	4.1500	2.0130	88.2000	250.00	2.1270	2.1270	41.5000	4.0260	0.0000	0.85	47.05	5530
67.9140	4.2000	2.0780	88.2000	250.00	2.1920	2.1920	42.0000	4.1560	0.0000	0.88	47.62	5431
69.9130	4.3500	2.1430	88.2000	250.00	2.2560	2.2560	43.5000	4.2860	0.0000	0.90	49.32	5465
71.9110	4.4500	2.2080	88.2000	250.00	2.3210	2.3210	44.5000	4.4160	0.0000	0.93	50.45	5434
73.9090	4.5500	2.2810	88.2000	250.00	2.3940	2.3940	45.5000	4.5620	0.0000	0.96	51.59	5387
75.9070	4.6500	2.3460	88.2000	250.00	2.4590	2.4590	46.5000	4.6920	0.0000	0.98	52.72	5360
77.9050	4.8000	2.4110	88.2000	250.00	2.5240	2.5240	48.0000	4.8220	0.0000	1.01	54.42	5390
79.9040	4.9000	2.4760	88.2000	250.00	2.5890	2.5890	49.0000	4.9520	0.0000	1.04	55.56	5365
81.9020	5.0000	2.5410	88.2000	250.00	2.6540	2.6540	50.0000	5.0820	0.0000	1.06	56.69	5340
83.9000	5.1500	2.6140	88.2000	250.00	2.7270	2.7270	51.5000	5.2280	0.0000	1.09	58.39	5353
85.8980	5.2500	2.6790	88.2000	250.00	2.7920	2.7920	52.5000	5.3580	0.0000	1.12	59.52	5330
87.8960	5.3000	2.7440	88.2000	250.00	2.8570	2.8570	53.0000	5.4880	0.0000	1.14	60.09	5258
89.8940	5.3500	2.8080	88.2000	250.00	2.9220	2.9220	53.5000	5.6160	0.0000	1.17	60.66	5190
91.8920	5.4000	2.8730	88.2000	250.00	2.9870	2.9870	54.0000	5.7460	0.0000	1.19	61.22	5124
93.8900	5.4500	2.9460	88.2000	250.00	3.0600	3.0600	54.5000	5.8920	0.0000	1.22	61.79	5048
95.8880	5.5000	3.0110	88.2000	250.00	3.1250	3.1250	55.0000	6.0220	0.0000	1.25	62.36	4989
97.8860	5.5500	3.0760	88.2000	250.00	3.1900	3.1900	55.5000	6.1520	0.0000	1.28	62.93	4931
99.8840	5.6000	3.1410	88.2000	250.00	3.2550	3.2550	56.0000	6.2820	0.0000	1.30	63.49	4877
101.8820	5.7000	3.2060	88.2000	250.00	3.3200	3.3200	57.0000	6.4120	0.0000	1.33	64.63	4866
103.8800	5.8500	3.2710	88.2000	250.00	3.3850	3.3850	58.5000	6.5420	0.0000	1.35	66.33	4899
105.8780	5.9500	3.3440	88.2000	250.00	3.4580	3.4580	59.5000	6.6880	0.0000	1.38	67.46	4877
107.8760	6.1000	3.4090	88.2000	250.00	3.5230	3.5230	61.0000	6.8180	0.0000	1.41	69.16	4908
109.8740	6.2000	3.4740	88.2000	250.00	3.5880	3.5880	62.0000	6.9480	0.0000	1.44	70.29	4898
111.8720	6.3000	3.5470	88.2000	250.00	3.6610	3.6610	63.0000	7.0940	0.0000	1.46	71.43	4878
113.8700	6.4500	3.6120	88.2000	250.00	3.7260	3.7260	64.5000	7.2240	0.0000	1.49	73.13	4907
115.8680	6.5500	3.6770	88.2000	250.00	3.7910	3.7910	65.5000	7.3540	0.0000	1.52	74.26	4897
117.8660	6.6500	3.7420	88.2000	250.00	3.8560	3.8560	66.5000	7.4840	0.0000	1.54	75.40	4888
119.8640	6.7500	3.8070	88.2000	250.00	3.9200	3.9200	67.5000	7.6140	0.0000	1.57	76.53	4881
121.8630	6.9000	3.8720	88.2000	250.00	3.9850	3.9850	69.0000	7.7440	0.0000	1.59	78.23	4908
123.8610	0.1500	3.9450	88.2000	250.00	4.0580	4.0580	-1.5000	7.8900	0.0000	1.62	1.70	105
125.8590	0.1500	4.0100	88.2000	250.00	4.1230	4.1230	-1.5000	8.0200	0.0000	1.65	1.70	103
127.8570	0.1500	4.0750	88.2000	250.00	4.1880	4.1880	-1.5000	8.1500	0.0000	1.68	1.70	102

Data Uji Tarik AFS B2

Time	Load	Elong	Area	Length	Disp	Dis. Kontrol	Stress	Strain	Width	Strain	Strength	Modulus
0.0000	0.0000	0.0000	76.80	250.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	-	-
1.9770	0.0000	0.0000	76.80	250.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	-	-
3.9750	0.0000	0.0000	76.80	250.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	-	-
5.9730	0.5500	-0.0240	76.80	250.00	0.1140	0.1140	5.5000	-0.0480	0.0000	0.046	7.16	15705
7.9710	0.7000	0.0650	76.80	250.00	0.2030	0.2030	7.0000	0.1300	0.0000	0.08	9.11	11225
9.9700	0.8500	0.1380	76.80	250.00	0.2760	0.2760	8.5000	0.2760	0.0000	0.11	11.07	10025
11.9680	1.0000	0.2110	76.80	250.00	0.3490	0.3490	10.0000	0.4220	0.0000	0.14	13.02	9327
13.9660	1.1500	0.2760	76.80	250.00	0.4140	0.4140	11.5000	0.5520	0.0000	0.17	14.97	9042
15.9630	1.2500	0.3490	76.80	250.00	0.4870	0.4870	12.5000	0.6980	0.0000	0.19	16.28	8355
17.9620	1.4000	0.4140	76.80	250.00	0.5520	0.5520	14.0000	0.8280	0.0000	0.22	18.23	8256
19.9610	1.5000	0.4790	76.80	250.00	0.6170	0.6170	15.0000	0.9580	0.0000	0.25	19.53	7914
21.9590	1.6000	0.5440	76.80	250.00	0.6820	0.6820	16.0000	1.0880	0.0000	0.27	20.83	7637
23.9570	1.7500	0.6090	76.80	250.00	0.7470	0.7470	17.5000	1.2180	0.0000	0.30	22.79	7626
25.9550	1.8500	0.6820	76.80	250.00	0.8200	0.8200	18.5000	1.3640	0.0000	0.33	24.09	7344
27.9530	2.0000	0.7470	76.80	250.00	0.8850	0.8850	20.0000	1.4940	0.0000	0.35	26.04	7356
29.9510	2.1000	0.8120	76.80	250.00	0.9500	0.9500	21.0000	1.6240	0.0000	0.38	27.34	7196
31.9490	2.2000	0.8770	76.80	250.00	1.0150	1.0150	22.0000	1.7540	0.0000	0.41	28.65	7056
33.9470	2.3500	0.9420	76.80	250.00	1.0800	1.0800	23.5000	1.8840	0.0000	0.43	30.60	7083
35.9450	2.4500	1.0150	76.80	250.00	1.1530	1.1530	24.5000	2.0300	0.0000	0.46	31.90	6917
37.9430	2.6000	1.0800	76.80	250.00	1.2180	1.2180	26.0000	2.1600	0.0000	0.49	33.85	6949
39.9410	2.7000	1.1440	76.80	250.00	1.2820	1.2820	27.0000	2.2880	0.0000	0.51	35.16	6856
41.9390	2.8000	1.2090	76.80	250.00	1.3470	1.3470	28.0000	2.4180	0.0000	0.54	36.46	6767
43.9370	2.9500	1.2740	76.80	250.00	1.4120	1.4120	29.5000	2.5480	0.0000	0.56	38.41	6801
45.9350	3.0500	1.3470	76.80	250.00	1.4850	1.4850	30.5000	2.6940	0.0000	0.59	39.71	6686
47.9330	3.1500	1.4120	76.80	250.00	1.5500	1.5500	31.5000	2.8240	0.0000	0.62	41.02	6615
49.9310	3.3000	1.4770	76.80	250.00	1.6150	1.6150	33.0000	2.9540	0.0000	0.65	42.97	6652
51.9290	3.4000	1.5420	76.80	250.00	1.6800	1.6800	34.0000	3.0840	0.0000	0.67	44.27	6588
53.9270	3.5000	1.6070	76.80	250.00	1.7450	1.7450	35.0000	3.2140	0.0000	0.70	45.57	6529
55.9250	3.6000	1.6800	76.80	250.00	1.8180	1.8180	36.0000	3.3600	0.0000	0.73	46.88	6446
57.9230	3.7000	1.7450	76.80	250.00	1.8830	1.8830	37.0000	3.4900	0.0000	0.75	48.18	6396
59.9220	3.7500	1.8100	76.80	250.00	1.9480	1.9480	37.5000	3.6200	0.0000	0.78	48.83	6266
61.9200	3.8500	1.8750	76.80	250.00	2.0130	2.0130	38.5000	3.7500	0.0000	0.81	50.13	6226
63.9180	3.9000	1.9400	76.80	250.00	2.0780	2.0780	39.0000	3.8800	0.0000	0.83	50.78	6109
65.9160	4.0000	2.0130	76.80	250.00	2.1510	2.1510	40.0000	4.0260	0.0000	0.86	52.08	6053
67.9140	4.1500	2.0780	76.80	250.00	2.2160	2.2160	41.5000	4.1560	0.0000	0.89	54.04	6096
69.9120	4.2500	2.1430	76.80	250.00	2.2810	2.2810	42.5000	4.2860	0.0000	0.91	55.34	6065
71.9100	4.3500	2.2080	76.80	250.00	2.3460	2.3460	43.5000	4.4160	0.0000	0.94	56.64	6036
73.9080	4.4500	2.2810	76.80	250.00	2.4190	2.4190	44.5000	4.5620	0.0000	0.97	57.94	5988
75.9060	4.6000	2.3460	76.80	250.00	2.4840	2.4840	46.0000	4.6920	0.0000	0.99	59.90	6028
77.9040	4.7000	2.4110	76.80	250.00	2.5490	2.5490	47.0000	4.8220	0.0000	1.02	61.20	6002
79.9020	4.8000	2.4760	76.80	250.00	2.6140	2.6140	48.0000	4.9520	0.0000	1.05	62.50	5977
81.9000	4.9500	2.5410	76.80	250.00	2.6790	2.6790	49.5000	5.0820	0.0000	1.07	64.45	6015
83.8980	5.0500	2.6140	76.80	250.00	2.7520	2.7520	50.5000	5.2280	0.0000	1.10	65.76	5973
85.8960	5.1500	2.6790	76.80	250.00	2.8170	2.8170	51.5000	5.3580	0.0000	1.13	67.06	5951
87.8940	5.2500	2.7440	76.80	250.00	2.8810	2.8810	52.5000	5.4880	0.0000	1.15	68.36	5932
89.8920	5.3000	2.8080	76.80	250.00	2.9460	2.9460	53.0000	5.6160	0.0000	1.18	69.01	5856
91.8900	5.3500	2.8730	76.80	250.00	3.0110	3.0110	53.5000	5.7460	0.0000	1.20	69.66	5784
93.8880	5.3500	2.9460	76.80	250.00	3.0840	3.0840	53.5000	5.8920	0.0000	1.23	69.66	5647
95.8860	5.4500	3.0110	76.80	250.00	3.1490	3.1490	54.5000	6.0220	0.0000	1.26	70.96	5634
97.8840	5.5500	3.0760	76.80	250.00	3.2140	3.2140	55.5000	6.1520	0.0000	1.29	72.27	5621
99.8820	5.6000	3.1410	76.80	250.00	3.2790	3.2790	56.0000	6.2820	0.0000	1.31	72.92	5559
101.8810	5.6500	3.2060	76.80	250.00	3.3440	3.3440	56.5000	6.4120	0.0000	1.34	73.57	5500
103.8800	5.7500	3.2790	76.80	250.00	3.4170	3.4170	57.5000	6.5580	0.0000	1.37	74.87	5478
105.8780	5.8500	3.3440	76.80	250.00	3.4820	3.4820	58.5000	6.6880	0.0000	1.39	76.17	5469
107.8760	0.2000	3.4090	76.80	250.00	3.5470	3.5470	-2.0000	6.8180	0.0000	1.42	2.60	184
109.8730	0.2000	3.4740	76.80	250.00	3.6120	3.6120	-2.0000	6.9480	0.0000	1.44	2.60	180
111.8720	0.2000	3.5470	76.80	250.00	3.6850	3.6850	-2.0000	7.0940	0.0000	1.47	2.60	177
113.8700	0.2000	3.6120	76.80	250.00	3.7500	3.7500	-2.0000	7.2240	0.0000	1.50	2.60	174

Data Uji Tarik AFS B3

Time	Load	Elong	Area	Length	Disp	Dis. Kontrol	Stress	Strain	Width	Strain	Strength	Modulus
0.0000	0.0000	0.0000	86.40	250.00	-0.0080	-0.0080	0.0000	0.0000	0.0000	-	-	-
1.9770	-0.2000	0.0000	86.40	250.00	-0.1300	-0.1300	-2.0000	0.0000	0.0000	-	-	-
3.9750	-0.1500	0.0000	86.40	250.00	-0.0570	-0.0570	-1.5000	0.0000	0.0000	-	-	-
5.9730	0.0000	0.0000	86.40	250.00	0.0080	0.0080	0.0000	0.0000	0.0000	-	-	-
7.9710	0.1500	0.0080	86.40	250.00	0.0730	0.0730	1.5000	0.0160	0.0000	0.03	1.74	5946
9.9690	0.3000	0.0730	86.40	250.00	0.1380	0.1380	3.0000	0.1460	0.0000	0.06	3.47	6290
11.9670	0.4500	0.1460	86.40	250.00	0.2110	0.2110	4.5000	0.2920	0.0000	0.08	5.21	6171
13.9650	0.6000	0.2110	86.40	250.00	0.2760	0.2760	6.0000	0.4220	0.0000	0.11	6.94	6290
15.9640	0.7000	0.2760	86.40	250.00	0.3410	0.3410	7.0000	0.5520	0.0000	0.14	8.10	5940
17.9620	0.8500	0.3410	86.40	250.00	0.4060	0.4060	8.5000	0.6820	0.0000	0.16	9.84	6058
19.9600	0.9500	0.4060	86.40	250.00	0.4710	0.4710	9.5000	0.8120	0.0000	0.19	11.00	5836
21.9580	1.1000	0.4790	86.40	250.00	0.5440	0.5440	11.0000	0.9580	0.0000	0.22	12.73	5851
23.9570	1.2500	0.5440	86.40	250.00	0.6090	0.6090	12.5000	1.0880	0.0000	0.24	14.47	5939
25.9550	1.3500	0.6090	86.40	250.00	0.6740	0.6740	13.5000	1.2180	0.0000	0.27	15.63	5796
27.9520	1.5000	0.6740	86.40	250.00	0.7390	0.7390	15.0000	1.3480	0.0000	0.30	17.36	5873
29.9510	1.6000	0.7390	86.40	250.00	0.8040	0.8040	16.0000	1.4780	0.0000	0.32	18.52	5758
31.9480	1.7500	0.8120	86.40	250.00	0.8770	0.8770	17.5000	1.6240	0.0000	0.35	20.25	5774
33.9470	1.8500	0.8770	86.40	250.00	0.9420	0.9420	18.5000	1.7540	0.0000	0.38	21.41	5683
35.9450	2.0000	0.9420	86.40	250.00	1.0060	1.0060	20.0000	1.8840	0.0000	0.40	23.15	5753
37.9430	2.1500	1.0060	86.40	250.00	1.0710	1.0710	21.5000	2.0120	0.0000	0.43	24.88	5809
39.9410	2.2500	1.0710	86.40	250.00	1.1360	1.1360	22.5000	2.1420	0.0000	0.45	26.04	5731
41.9390	2.4000	1.1440	86.40	250.00	1.2090	1.2090	24.0000	2.2880	0.0000	0.48	27.78	5744
43.9370	2.5000	1.2090	86.40	250.00	1.2740	1.2740	25.0000	2.4180	0.0000	0.51	28.94	5678
45.9350	2.6500	1.2740	86.40	250.00	1.3390	1.3390	26.5000	2.5480	0.0000	0.54	30.67	5727
47.9330	2.7500	1.3390	86.40	250.00	1.4040	1.4040	27.5000	2.6780	0.0000	0.56	31.83	5668
49.9310	2.9000	1.4040	86.40	250.00	1.4690	1.4690	29.0000	2.8080	0.0000	0.59	33.56	5712
51.9290	3.0000	1.4770	86.40	250.00	1.5420	1.5420	30.0000	2.9540	0.0000	0.62	34.72	5629
53.9270	3.1500	1.5420	86.40	250.00	1.6070	1.6070	31.5000	3.0840	0.0000	0.64	36.46	5672
55.9250	3.2500	1.6070	86.40	250.00	1.6720	1.6720	32.5000	3.2140	0.0000	0.67	37.62	5624
57.9230	3.3500	1.6720	86.40	250.00	1.7370	1.7370	33.5000	3.3440	0.0000	0.69	38.77	5580
59.9220	3.5000	1.7370	86.40	250.00	1.8020	1.8020	35.0000	3.4740	0.0000	0.72	40.51	5620
61.9200	3.6000	1.8100	86.40	250.00	1.8750	1.8750	36.0000	3.6200	0.0000	0.75	41.67	5556
63.9180	3.7500	1.8750	86.40	250.00	1.9400	1.9400	37.5000	3.7500	0.0000	0.78	43.40	5593
65.9160	3.8500	1.9400	86.40	250.00	2.0050	2.0050	38.5000	3.8800	0.0000	0.80	44.56	5556
67.9140	3.8500	2.0050	86.40	250.00	2.0700	2.0700	38.5000	4.0100	0.0000	0.83	44.56	5382
69.9120	3.9500	2.0700	86.40	250.00	2.1350	2.1350	39.5000	4.1400	0.0000	0.85	45.72	5353
71.9100	4.0500	2.1430	86.40	250.00	2.2080	2.2080	40.5000	4.2860	0.0000	0.88	46.88	5307
73.9090	4.1500	2.2080	86.40	250.00	2.2730	2.2730	41.5000	4.4160	0.0000	0.91	48.03	5283
75.9060	4.2500	2.2730	86.40	250.00	2.3380	2.3380	42.5000	4.5460	0.0000	0.94	49.19	5260
77.9040	4.3500	2.3380	86.40	250.00	2.4030	2.4030	43.5000	4.6760	0.0000	0.96	50.35	5238
79.9020	4.5000	2.4110	86.40	250.00	2.4760	2.4760	45.0000	4.8220	0.0000	0.99	52.08	5259
81.9000	4.6000	2.4760	86.40	250.00	2.5410	2.5410	46.0000	4.9520	0.0000	1.02	53.24	5238
83.8980	4.7000	2.5410	86.40	250.00	2.6060	2.6060	47.0000	5.0820	0.0000	1.04	54.40	5219
85.8960	4.8500	2.6060	86.40	250.00	2.6700	2.6700	48.5000	5.2120	0.0000	1.07	56.13	5256
87.8940	0.2500	2.6870	86.40	250.00	2.7520	2.7520	-2.5000	5.3740	0.0000	1.10	2.89	263
89.8920	0.2500	2.7350	86.40	250.00	2.8000	2.8000	-2.5000	5.4700	0.0000	1.12	2.89	258
91.8900	0.2500	2.8080	86.40	250.00	2.8730	2.8730	-2.5000	5.6160	0.0000	1.15	2.89	252
93.8880	0.2500	2.8730	86.40	250.00	2.9380	2.9380	-2.5000	5.7460	0.0000	1.18	2.89	246

DATA UJI GESER BALOK CB

LOAD CELL		LVDT 1	LVDT 2	LVDT 3	LVDT 1	LVDT 2	LVDT 3	SG TARI	SG GESE	SG BETON TEKAN	PG 1	PG 2	PG 3	PG 4	SG BETON GESER
0.19992	**0**	**0**	**0**	**0.01**	**0**	**0**	**-0.01**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.952381**
-0.73304	0.73304	-0.02	-0.02	-0.02	0.02	0.02	0.02	2.89855	1.93237	-4.7619	0	0	0	0	0.952381
-1.53272	1.53272	-0.04	-0.03	-0.03	0.04	0.03	0.03	7.72947	1.93237	-8.57143	0	0	0	0	0.952381
-3.06544	3.06544	-0.07	-0.07	-0.07	0.07	0.07	0.07	16.4251	1.93237	-19.0476	0	0	0	0	0.952381
-4.53152	4.53152	-0.11	-0.11	-0.1	0.11	0.11	0.1	24.1546	2.89855	-27.619	0	0	0	0	1.90476
-6.39744	6.39744	-0.15	-0.16	-0.15	0.15	0.16	0.15	35.7488	2.89855	-39.0476	0	0	0	0	1.90476
-8.6632	8.6632	-0.21	-0.22	-0.21	0.21	0.22	0.21	49.2754	2.89855	-53.3333	0.00048	0	0	0	1.90476
-9.6628	9.6628	-0.23	-0.24	-0.23	0.23	0.24	0.23	57.0048	2.89855	-61.9048	0.00048	0	0	0	1.90476
-9.6628	9.6628	-0.23	-0.24	-0.23	0.23	0.24	0.23	57.0048	2.89855	-61.9048	0	0	0	0	1.90476
-9.996	9.996	-0.25	-0.26	-0.25	0.25	0.26	0.25	61.8358	2.89855	-64.7619	0	0	0	-0.00048	1.90476
-9.6628	9.6628	-0.25	-0.26	-0.25	0.25	0.26	0.25	63.7681	1.93237	-66.6667	0.00048	0	0	0.00048	0.952381
-9.6628	9.6628	-0.24	-0.26	-0.25	0.24	0.26	0.25	64.7343	1.93237	-66.6667	0.00048	0	0	0.00048	0.952381
-9.6628	9.6628	-0.25	-0.26	-0.25	0.25	0.26	0.25	63.7681	1.93237	-66.6667	0	0	0	0	0.952381
-10.3958	10.3958	-0.26	-0.28	-0.27	0.26	0.28	0.27	69.5652	0.96618	-71.4286	0	0	0	0	0.952381
-11.1289	11.1289	-0.29	-0.3	-0.29	0.29	0.3	0.29	75.3623	0	-78.0952	0	0	0	0	0.952381
-12.3284	12.3284	-0.31	-0.33	-0.32	0.31	0.33	0.32	86.9565	0.96618	-87.619	0.00048	0	0.00048	0	0
-14.8607	14.8607	-0.37	-0.41	-0.4	0.37	0.41	0.4	117.874	1.93237	-107.619	0.00048	0	0.00048	0	0.952381
-17.2598	17.2598	-0.44	-0.48	-0.47	0.44	0.48	0.47	146.86	2.89855	-129.524	0.00048	0	0	0	0.952381
-24.3236	24.3236	-0.66	-0.74	-0.73	0.66	0.74	0.73	257.005	7.72947	-198.095	0.00097	0	0	0	1.90476
-26.9226	26.9226	-0.76	-0.85	-0.83	0.76	0.85	0.83	295.652	8.69565	-224.762	0.00097	0	0	0	1.90476
-29.1883	29.1883	-0.84	-0.94	-0.92	0.84	0.94	0.92	330.435	8.69565	-246.667	0.00097	0	0	0	1.90476
-36.8519	36.8519	-1.13	-1.27	-1.23	1.13	1.27	1.23	433.816	12.5604	-323.81	0.00145	0	0	0	0.952381
-38.1847	38.1847	-1.24	-1.39	-1.35	1.24	1.39	1.35	469.565	13.5266	-344.762	0.00097	0	0.00048	0	-2.85714
-38.0514	38.0514	-1.24	-1.39	-1.35	1.24	1.39	1.35	469.565	13.5266	-343.81	0.00145	0	0.00048	-0.00048	-1.90476
-38.0514	38.0514	-1.24	-1.39	-1.35	1.24	1.39	1.35	468.599	13.5266	-343.81	0.00145	0	0.00048	-0.00048	-2.85714
-39.3176	39.3176	-1.27	-1.42	-1.39	1.27	1.42	1.39	480.193	13.5266	-352.381	0.00145	0	0	-0.00048	-2.85714
-42.7829	42.7829	-1.36	-1.53	-1.48	1.36	1.53	1.48	515.942	14.4928	-381.905	0.00145	0	0	-0.00048	-3.80952
-47.381	47.381	-1.55	-1.74	-1.69	1.55	1.74	1.69	581.643	16.4251	-425.714	0.00194	0	0	-0.00145	-7.61905
-50.1799	50.1799	-1.65	-1.85	-1.8	1.65	1.85	1.8	621.256	17.3913	-451.429	0.00194	0	0	-0.00194	-9.52381
-54.045	54.045	-1.81	-2.03	-1.96	1.81	2.03	1.96	675.362	20.2899	-486.667	0.00242	0.00048	0.00048	-0.00339	-10.4762
-57.7769	57.7769	-2	-2.24	-2.17	2	2.24	2.17	738.164	25.1208	-526.667	0.00242	0.00145	0.00048	-0.00436	-8.57143
-56.9772	56.9772	-2	-2.24	-2.17	2	2.24	2.17	735.266	26.087	-523.81	0.00242	0.00145	0.00048	-0.00436	-7.61905
-56.4441	56.4441	-2	-2.23	-2.17	2	2.23	2.17	732.367	26.087	-520.952	0.00242	0.00194	0.00048	-0.00436	-7.61905
-56.0442	56.0442	-2	-2.23	-2.17	2	2.23	2.17	731.401	26.087	-520	0.00242	0.00194	0.00048	-0.00436	-8.57143
-60.709	60.709	-2.11	-2.36	-2.29	2.11	2.36	2.29	774.879	27.0531	-555.238	0.00242	0.00242	0.00048	-0.00436	-8.57143
-64.041	64.041	-2.24	-2.5	-2.43	2.24	2.5	2.43	818.357	28.9855	-586.667	0.00242	0.0029	0.00048	-0.00484	-4.7619
-70.5718	70.5718	-2.55	-2.84	-2.76	2.55	2.84	2.76	909.179	33.8164	-650.476	0.00242	0.00048	0.00048	-0.00436	621.905
-74.037	74.037	-2.72	-3.04	-2.98	2.72	3.04	2.98	957.488	48.3092	-683.81	0.00194	0.00048	0	-0.01162	816.19
-77.569	77.569	-2.86	-3.21	-3.15	2.86	3.21	3.15	1005.8	58.9372	-716.19	0.00242	0	0	-0.0121	959.048
-80.2346	80.2346	-2.99	-3.35	-3.29	2.99	3.35	3.29	1041.55	71.4976	-741.905	0.00242	-0.00097	0	-0.015	1166.67
-81.634	81.634	-3.12	-3.51	-3.46	3.12	3.51	3.46	1068.6	88.8889	-760.952	0.00194	-0.00194	0.00048	-0.01597	1358.1
-79.7681	79.7681	-3.12	-3.51	-3.47	3.12	3.51	3.47	1059.9	105.314	-751.429	0.00194	-0.00194	0	-0.01549	1409.52
-79.035	79.035	-3.12	-3.5	-3.46	3.12	3.5	3.46	1057	112.077	-748.571	0.00194	-0.00194	0	-0.01549	1426.67
-80.701	80.701	-3.15	-3.54	-3.5	3.15	3.54	3.5	1068.6	114.01	-760	0.00194	-0.00145	0	-0.01549	1443.81
-85.5658	85.5658	-3.31	-3.71	-3.67	3.31	3.71	3.67	1119.81	149.758	-800.952	0.00242	-0.00097	0	-0.01597	1562.86
-88.4313	88.4313	-3.48	-3.91	-3.87	3.48	3.91	3.87	1154.59	270.531	-827.619	0.00145	0.02662	0	-0.015	1947.62
-92.563	92.563	-3.7	-4.16	-4.12	3.7	4.16	4.12	1208.7	376.812	-868.571	0.00097	0.05953	-0.00048	-0.01355	2630.48
-95.6284	95.6284	-3.88	-4.35	-4.31	3.88	4.35	4.31	1249.28	458.937	-899.048	0.00048	0.10019	-0.00097	-0.01307	3273.33
-99.3602	99.3602	-4.11	-4.6	-4.55	4.11	4.6	4.55	1299.52	585.507	-936.19	-0.0029	0.15682	-0.00145	-0.0121	4694.29
-106.357	106.357	-4.22	-5.02	-4.96	4.22	5.02	4.96	1393.24	794.203	-1008.57	-0.00726	0.27975	-0.0029	-0.0121	6327.62
-107.957	107.957	-4.31	-5.13	-5.07	4.31	5.13	5.07	1415.46	847.343	-1024.76	-0.00871	0.33832	-0.00387	-0.0121	6723.81
-108.557	108.557	-4.35	-5.18	-5.12	4.35	5.18	5.12	1424.15	863.768	-1032.38	-0.0092	0.36106	-0.00436	-0.0121	6920
-109.556	109.556	-4.4	-5.24	-5.18	4.4	5.24	5.18	1435.75	875.362	-1040.95	-0.01016	0.37994	-0.00436	-0.0121	7113.33
-114.088	114.088	-4.75	-5.64	-5.6	4.75	5.64	5.6	1496.62	1002.9	-1091.43	-0.0121	0.48013	-0.00581	-0.01404	8579.05
-116.02	116.02	-4.92	-5.84	-5.81	4.92	5.84	5.81	1525.6	1091.79	-1115.24	0	0.53434	-0.00823	-0.01452	9585.71
-117.686	117.686	-5.14	-6.08	-6.07	5.14	6.08	6.07	1564.25	1181.64	-1140.95	0.01452	0.54595	-0.00968	-0.01404	10630.5
-118.686	118.686	-5.27	-6.23	-6.23	5.27	6.23	6.23	1586.47	1234.78	-1156.19	0.02614	0.55563	-0.01065	-0.01404	11219
-120.285	120.285	-5.43	-6.41	-6.42	5.43	6.41	6.42	1613.53	1309.18	-1176.19	0.04453	0.57209	-0.01258	-0.01404	11999
-121.218	121.218	-5.57	-6.57	-6.59	5.57	6.57	6.59	1638.65	1378.74	-1192.38	0.0634	0.58467	-0.01452	-0.01404	13091.4
-122.818	122.818	-5.69	-6.7	-6.72	5.69	6.7	6.72	1660.87	1438.65	-1209.52	0.07647	0.59629	-0.01597	-0.01404	13841
-124.75	124.75	-5.85	-6.89	-6.91	5.85	6.89	6.91	1688.89	1532.37	-1230.48	0.09825	0.61904	-0.01791	-0.01404	14944.8
-117.686	117.686	-5.91	-6.99	-7.12	5.91	6.99	7.12	1632.85	1505.31	-1181.9	0.10164	0.6142	-0.01839	-0.01404	14994.3
-114.621	114.621	-6.2	-7.43	-7.75	6.2	7.43	7.75	1592.27	1499.52	-1151.43	0.10793	0.61371	-0.01839	-0.01307	14891.4
-113.621	113.621	-6.22	-7.48	-7.83	6.22	7.48	7.83	1580.68	1499.52	-1144.76	0.1089	0.61371	-0.01839	-0.01307	14869.5
-112.688	112.688	-6.25	-7.52	-7.88	6.25	7.52	7.88	1571.98	1498.55	-1138.1	0.10938	0.61371	-0.01839	-0.01258	14848.6
-109.556	109.556	-6.38	-7.72	-8.21	6.38	7.72	8.21	1536.23	1492.75	-1111.43	0.11229	0.61371	-0.01839	-0.01355	14760
-109.156	109.156	-6.39	-7.76	-8.25	6.39	7.76	8.25	1532.37	1491.79	-1107.62	0.11277	0.61371	-0.01839	-0.01404	14753.3
-109.156	109.156	-6.42	-7.8	-8.31	6.42	7.8	8.31	1531.4	1493.72	-1107.62	0.11326	0.6142	-0.01839	-0.01404	14746.7

-109.156	109.156	-6.51	-7.93	-8.48	6.51	7.93	8.48	1525.6	1496.62	-1103.81	0.11471	0.61468	-0.01839	-0.01404	14723.8
-109.156	109.156	-6.54	-7.99	-8.56	6.54	7.99	8.56	1524.64	1495.65	-1103.81	0.11519	0.6142	-0.01839	-0.01355	14719
-105.291	105.291	-6.54	-8.01	-8.63	6.54	8.01	8.63	1490.82	1482.13	-1076.19	0.11713	0.61274	-0.01839	-0.01355	14644.8
-104.825	104.825	-6.54	-8.01	-8.63	6.54	8.01	8.63	1485.99	1479.23	-1073.33	0.11761	0.61226	-0.01839	-0.01355	14637.1
-104.492	104.492	-6.54	-8.01	-8.64	6.54	8.01	8.64	1484.06	1475.36	-1070.48	0.1181	0.61129	-0.01839	-0.01355	14631.4
-104.158	104.158	-6.54	-8.01	-8.64	6.54	8.01	8.64	1479.23	1472.46	-1069.52	0.1181	0.61081	-0.01839	-0.01355	14625.7
-103.359	103.359	-6.59	-8.08	-8.74	6.59	8.08	8.74	1464.73	1432.85	-1073.33	0.12197	0.60645	-0.01888	-0.01355	14594.3
-105.758	105.758	-6.69	-8.2	-8.88	6.69	8.2	8.88	1483.09	1445.41	-1089.52	0.12294	0.60887	-0.01888	-0.01307	14603.8
-106.357	106.357	-6.79	-8.35	-9.07	6.79	8.35	9.07	1483.09	1453.14	-1092.38	0.1239	0.61032	-0.01888	-0.01258	14601
-106.957	106.957	-6.84	-8.41	-9.15	6.84	8.41	9.15	1486.96	1457	-1095.24	0.1239	0.61081	-0.01888	-0.01258	14601.9
-107.557	107.557	-6.9	-8.51	-9.27	6.9	8.51	9.27	1489.86	1460.87	-1099.05	0.12439	0.61178	-0.01888	-0.01307	14606.7
-107.557	107.557	-6.92	-8.53	-9.3	6.92	8.53	9.3	1489.86	1461.84	-1099.05	0.12487	0.61178	-0.01888	-0.01307	14607.6
-107.957	107.957	-7.11	-8.82	-9.67	7.11	8.82	9.67	1490.82	1468.6	-1100.95	0.12584	0.61323	-0.01888	-0.01307	14603.8
-108.557	108.557	-7.3	-9.09	-10.02	7.3	9.09	10.02	1499.52	1478.26	-1105.71	0.12729	0.61516	-0.01888	-0.01307	14608.6
-108.557	108.557	-7.32	-9.12	-10.06	7.32	9.12	10.06	1498.55	1479.23	-1105.71	0.12729	0.61565	-0.01936	-0.01307	14604.8
-110.489	110.489	-7.78	-9.76	-10.89	7.78	9.76	10.89	1515.94	1508.21	-1120	0.13165	0.62194	-0.01888	-0.01355	14606.7
-110.023	110.023	-7.87	-9.89	-11.07	7.87	9.89	11.07	1513.04	1507.25	-1116.19	0.13213	0.62194	-0.01888	-0.01355	14601.9
-110.489	110.489	-7.9	-9.94	-11.12	7.9	9.94	11.12	1515.94	1510.14	-1119.05	0.13262	0.62242	-0.01888	-0.01355	14607.6
-110.489	110.489	-7.95	-10	-11.2	7.95	10	11.2	1514.98	1510.14	-1119.05	0.13262	0.62242	-0.01888	-0.01355	14606.7
-110.489	110.489	-7.99	-10.06	-11.27	7.99	10.06	11.27	1516.91	1512.08	-1120	0.1331	0.62291	-0.01888	-0.01355	14604.8
-110.889	110.889	-8.05	-10.16	-11.4	8.05	10.16	11.4	1520.77	1518.84	-1122.86	0.13358	0.62388	-0.01888	-0.01355	14606.7
-110.889	110.889	-8.08	-10.18	-11.43	8.08	10.18	11.43	1520.77	1519.81	-1122.86	0.13358	0.62436	-0.01888	-0.01355	14608.6
-111.289	111.289	-8.1	-10.22	-11.48	8.1	10.22	11.48	1523.67	1522.71	-1125.71	0.13407	0.62484	-0.01888	-0.01355	14611.4
-110.889	110.889	-8.17	-10.31	-11.6	8.17	10.31	11.6	1521.74	1522.71	-1122.86	0.13455	0.62484	-0.01936	-0.01355	14609.5
-111.755	111.755	-8.35	-10.56	-11.92	8.35	10.56	11.92	1528.5	1533.33	-1128.57	0.13649	0.62775	-0.01888	-0.01355	14613.3
-112.222	112.222	-8.42	-10.66	-12.05	8.42	10.66	12.05	1533.33	1540.1	-1131.43	0.13697	0.6292	-0.01888	-0.01355	14615.2
-112.688	112.688	-8.73	-11.1	-12.62	8.73	11.1	12.62	1540.1	1555.56	-1135.24	0.14084	0.63307	-0.01888	-0.01355	14625.7
-113.088	113.088	-8.76	-11.15	-12.67	8.76	11.15	12.67	1543	1558.45	-1137.14	0.14133	0.63404	-0.01888	-0.01355	14626.7
-113.088	113.088	-8.8	-11.2	-12.73	8.8	11.2	12.73	1543	1559.42	-1138.1	0.14181	0.63452	-0.01888	-0.01355	14627.6
-113.088	113.088	-8.93	-11.4	-13	8.93	11.4	13	1543	1563.29	-1139.05	0.14326	0.63549	-0.01888	-0.01355	14627.6
-114.621	114.621	-9.23	-11.82	-13.52	9.23	11.82	13.52	1560.39	1588.41	-1148.57	0.14714	0.64227	-0.01888	-0.01355	14656.2
-115.021	115.021	-9.28	-11.89	-13.61	9.28	11.89	13.61	1563.29	1592.27	-1152.38	0.1481	0.64324	-0.01888	-0.01355	14661.9
-115.354	115.354	-9.39	-12.03	-13.79	9.39	12.03	13.79	1566.18	1599.03	-1155.24	0.14956	0.64517	-0.01888	-0.01355	14678.1
-115.354	115.354	-9.41	-12.06	-13.83	9.41	12.06	13.83	1566.18	1599.03	-1155.24	0.15004	0.64517	-0.01888	-0.01355	14677.1
-115.687	115.687	-9.55	-12.26	-14.09	9.55	12.26	14.09	1570.05	1607.73	-1158.1	0.15246	0.64759	-0.01888	-0.01355	14691.4
-116.02	116.02	-9.62	-12.37	-14.22	9.62	12.37	14.22	1571.98	1612.56	-1160.95	0.15343	0.64953	-0.01888	-0.01355	14701.9
-116.02	116.02	-9.68	-12.46	-14.34	9.68	12.46	14.34	1572.95	1616.43	-1160.95	0.15391	0.65001	-0.01888	-0.01355	14707.6
-116.353	116.353	-9.71	-12.49	-14.39	9.71	12.49	14.39	1575.85	1618.36	-1163.81	0.1544	0.6505	-0.01888	-0.01307	14714.3
-116.353	116.353	-9.74	-12.54	-14.44	9.74	12.54	14.44	1575.85	1619.32	-1164.76	0.15488	0.65146	-0.01888	-0.01307	14715.2
-116.353	116.353	-9.76	-12.57	-14.48	9.76	12.57	14.48	1575.85	1620.29	-1163.81	0.15488	0.65146	-0.01888	-0.01355	14716.2
-117.02	117.02	-9.99	-12.88	-14.89	9.99	12.88	14.89	1582.61	1633.82	-1169.52	0.15827	0.65485	-0.01888	-0.01355	14745.7
-117.353	117.353	-10.22	-13.21	-15.32	10.22	13.21	15.32	1587.44	1646.38	-1170.48	0.16166	0.65921	-0.01888	-0.01355	14772.4
-117.353	117.353	-10.29	-13.31	-15.45	10.29	13.31	15.45	1586.47	1648.31	-1170.48	0.16262	0.65921	-0.01888	-0.01355	14777.1
-116.687	116.687	-10.58	-13.73	-16.02	10.58	13.73	16.02	1581.64	1649.28	-1163.81	0.16504	0.66018	-0.01888	-0.01452	14781
-116.02	116.02	-10.77	-14.02	-16.41	10.77	14.02	16.41	1574.88	1646.38	-1158.1	0.16601	0.66018	-0.01936	-0.015	14780
-115.354	115.354	-10.86	-14.15	-16.58	10.86	14.15	16.58	1571.01	1644.44	-1153.33	0.1665	0.65969	-0.01936	-0.015	14775.2
-115.354	115.354	-10.98	-14.33	-16.82	10.98	14.33	16.82	1570.05	1644.44	-1153.33	0.16698	0.65969	-0.01888	-0.015	14773.3
-115.354	115.354	-11.06	-14.43	-16.96	11.06	14.43	16.96	1570.05	1644.44	-1154.29	0.16746	0.65969	-0.01936	-0.01549	14776.2
-115.687	115.687	-11.13	-14.53	-17.09	11.13	14.53	17.09	1571.98	1645.41	-1154.29	0.16746	0.66018	-0.01888	-0.01549	14779
-115.354	115.354	-11.5	-15.06	-17.81	11.5	15.06	17.81	1569.08	1651.21	-1151.43	0.16988	0.66211	-0.01888	-0.01597	14775.2
-115.021	115.021	-11.54	-15.13	-17.9	11.54	15.13	17.9	1567.15	1651.21	-1149.52	0.16988	0.66211	-0.01936	-0.01597	14772.4
-115.021	115.021	-11.67	-15.3	-18.13	11.67	15.3	18.13	1566.18	1651.21	-1149.52	0.17037	0.66211	-0.01936	-0.01597	14769.5
-115.021	115.021	-11.69	-15.33	-18.16	11.69	15.33	18.16	1566.18	1652.17	-1148.57	0.17085	0.66211	-0.01936	-0.01597	14772.4
-115.021	115.021	-11.71	-15.36	-18.2	11.71	15.36	18.2	1565.22	1652.17	-1149.52	0.17085	0.6626	-0.01888	-0.01646	14771.4
-115.354	115.354	-11.78	-15.46	-18.34	11.78	15.46	18.34	1568.12	1656.04	-1150.48	0.17134	0.66308	-0.01888	-0.01646	14773.3
-115.021	115.021	-11.84	-15.54	-18.45	11.84	15.54	18.45	1566.18	1654.11	-1147.62	0.17182	0.66308	-0.01888	-0.01646	14770.5
-115.687	115.687	-11.99	-15.75	-18.72	11.99	15.75	18.72	1571.98	1660.87	-1152.38	0.17279	0.66453	-0.01888	-0.01646	14781
-115.687	115.687	-12.03	-15.81	-18.79	12.03	15.81	18.79	1571.01	1661.84	-1152.38	0.17327	0.66502	-0.01888	-0.01646	14780
-116.02	116.02	-12.18	-16.01	-19.07	12.18	16.01	19.07	1573.91	1666.67	-1155.24	0.17424	0.66647	-0.01888	-0.01694	14790.5
-116.02	116.02	-12.2	-16.04	-19.1	12.2	16.04	19.1	1572.95	1666.67	-1155.24	0.17472	0.66647	-0.01936	-0.01694	14791.4
-116.02	116.02	-12.22	-16.07	-19.15	12.22	16.07	19.15	1573.91	1667.63	-1154.29	0.17472	0.66695	-0.01936	-0.01694	14791.4
-116.02	116.02	-12.24	-16.1	-19.19	12.24	16.1	19.19	1572.95	1667.63	-1155.24	0.17472	0.66695	-0.01888	-0.01694	14794.3
-116.353	116.353	-12.29	-16.17	-19.28	12.29	16.17	19.28	1575.85	1671.5	-1157.14	0.17521	0.66792	-0.01936	-0.01694	14797.1
-116.687	116.687	-12.41	-16.33	-19.49	12.41	16.33	19.49	1577.78	1677.29	-1160	0.17618	0.66937	-0.01888	-0.01694	14804.8
-116.687	116.687	-12.45	-16.39	-19.57	12.45	16.39	19.57	1577.78	1676.33	-1160	0.17666	0.66937	-0.01888	-0.01694	14809.5
-116.687	116.687	-12.47	-16.42	-19.61	12.47	16.42	19.61	1577.78	1677.29	-1160	0.17666	0.66986	-0.01888	-0.01742	14809.5
-117.02	117.02	-12.52	-16.48	-19.7	12.52	16.48	19.7	1580.68	1680.19	-1162.86	0.17714	0.67082	-0.01888	-0.01742	14819
-117.353	117.353	-12.57	-16.56	-19.8	12.57	16.56	19.8	1582.61	1685.02	-1163.81	0.17763	0.67131	-0.01888	-0.01742	14824.8
-117.02	117.02	-12.61	-16.62	-19.89	12.61	16.62	19.89	1581.64	1684.06	-1162.86	0.17811	0.67179	-0.01888	-0.01742	14824.8
-117.02	117.02	-12.63	-16.65	-19.92	12.63	16.65	19.92	1581.64	1685.02	-1162.86	0.1786	0.67179	-0.01888	-0.01742	14828.6
-117.353	117.353	-12.66	-16.69	-19.97	12.66	16.69	19.97	1583.57	1687.92	-1163.81	0.17908	0.67228	-0.01888	-0.01742	14831.4
-117.353	117.353	-12.68	-16.72	-20.01	12.68	16.72	20.01	1583.57	1687.92	-1164.76	0.17908	0.67276	-0.01888	-0.01791	14834.3
-117.686	117.686	-12.72	-16.76	-20.06	12.72	16.76	20.06	1585.51	1690.82	-1166.67	0.17908	0.67324	-0.01888	-0.01742	14838.1

-117.353	117.353	-12.75	-16.82	-20.15	12.75	16.82	20.15	1583.57	1689.86	-1163.81	0.17956	0.67324	-0.01888	-0.01742	14842.9
-110.023	110.023	-12.78	-16.89	-20.3	12.78	16.89	20.3	1528.5	1640.58	-1120	0.18198	0.6655	-0.01936	-0.01936	14808.6
-101.826	101.826	-12.56	-16.66	-20.07	12.56	16.66	20.07	1454.11	1573.91	-1061.9	0.18053	0.65437	-0.01936	-0.02178	14736.2
-68.2394	68.2394	-11.56	-15.49	-18.92	11.56	15.49	18.92	1121.74	1246.38	-807.619	0.17182	0.61274	-0.02033	-0.02807	14105.7
-32.1871	32.1871	-10.09	-13.78	-17.19	10.09	13.78	17.19	704.348	862.802	-493.333	0.16117	0.57015	-0.01984	-0.02614	12670.5
-21.9912	21.9912	-9.59	-13.18	-16.55	9.59	13.18	16.55	580.676	759.42	-395.238	0.15682	0.55708	-0.01936	-0.02323	12137.1
-19.1257	19.1257	-9.44	-13	-16.36	9.44	13	16.36	544.928	730.435	-368.571	0.15536	0.5537	-0.01936	-0.02226	11978.1
-13.4613	13.4613	-9.11	-12.59	-15.92	9.11	12.59	15.92	472.464	667.633	-309.524	0.15149	0.54837	-0.01888	-0.01888	11607.6
-12.3284	12.3284	-9.03	-12.5	-15.82	9.03	12.5	15.82	458.937	658.937	-298.095	0.15052	0.54837	-0.01888	-0.01839	11549.5
-11.7953	11.7953	-9.01	-12.46	-15.78	9.01	12.46	15.78	452.174	654.106	-294.286	0.15052	0.54886	-0.01936	-0.01839	11525.7
0.53312	-0.53312	-8.13	-11.41	-14.63	8.13	11.41	14.63	302.415	553.623	-173.333	0.13939	0.53627	-0.01791	-0.0121	10835.2
0.53312	-0.53312	-8.11	-11.39	-14.61	8.11	11.39	14.61	301.449	550.725	-171.429	0.13939	0.53627	-0.01791	-0.0121	10816.2
0.53312	-0.53312	-8.1	-11.38	-14.59	8.1	11.38	14.59	300.483	547.826	-170.476	0.13891	0.53627	-0.01791	-0.0121	10795.2
0.53312	-0.53312	-8.1	-11.37	-14.59	8.1	11.37	14.59	298.551	547.826	-169.524	0.13891	0.53627	-0.01791	-0.0121	10790.5
0.53312	-0.53312	-8.09	-11.36	-14.58	8.09	11.36	14.58	298.551	546.86	-169.524	0.13842	0.53676	-0.01791	-0.01258	10783.8

DATA UJI GESER BALOK SBA-1

	LOAD	LVDT	SG TARIK	SG GESER	G BETON TEKA	SG FRP 1	SG FRP 2
1	0.06664	0.000	7.729	1.93	0.952	-0.962	-0.962
5	0.3332	0.000	7.729	(1.93)	-1.905	0.000	0.000
9	1.3328	0.050	9.662	(0.97)	-7.619	0.000	0.000
13	2.3324	0.090	5.797	(5.80)	-18.095	1.923	0.962
17	4.13168	0.220	24.155	(0.97)	-25.714	0.000	0.962
21	6.13088	0.350	35.749	(0.97)	-38.095	0.000	0.000
25	8.46328	0.470	51.208	(1.93)	-51.429	1.923	0.000
29	10.3292	0.580	64.734	(5.80)	-65.714	0.000	0.000
33	11.2622	0.640	71.498	6.76	-73.333	-0.962	0.962
37	12.9948	0.720	85.990	(0.97)	-84.762	0.962	0.962
41	16.7266	0.850	116.908	-	-112.381	0.962	0.962
45	20.7917	1.040	170.048	-	-148.571	0.962	1.923
49	25.7897	1.260	248.309	0.97	-196.190	0.962	1.923
53	30.921	1.470	336.232	6.76	-243.810	0.962	0.962
57	37.4517	1.760	436.715	7.73	-304.762	0.962	3.846
61	43.7825	2.030	524.638	30.92	-359.048	6.731	6.731
65	52.1125	2.390	638.647	52.17	-429.524	12.500	7.692
69	60.9756	2.760	743.961	76.33	-509.524	19.231	11.539
73	69.239	3.140	889.855	139.13	-577.143	21.154	1.923
77	79.3016	3.610	1008.700	210.63	-663.810	36.539	-13.462
81	89.8307	4.070	1143.960	290.82	-752.381	64.423	-25.000
85	100.227	4.580	1275.360	360.39	-842.857	111.538	-26.923
89	110.889	5.100	1419.320	421.26	-934.286	113.462	64.423
93	121.951	5.630	1561.350	503.38	-1032.380	113.462	150.962
97	132.547	6.170	1693.720	566.18	-1129.520	111.538	300.962
101	141.21	6.760	1846.380	642.51	-1222.860	113.462	863.462
105	151.539	7.330	1992.270	763.29	-1326.670	114.423	1705.770
109	160.336	7.940	2165.220	955.56	-1429.520	113.462	3674.040
113	165.867	8.600	2289.850	1,066.67	-1540.000	114.423	5062.500
117	166.533	9.440	2987.440	1,102.42	-1660.950	113.462	5433.650
121	166.067	10.360	3860.870	1,117.87	-1759.050	111.538	5657.690
125	167.733	11.280	5316.910	1,141.06	-1873.330	111.538	5913.460
129	164.068	11.520	5953.620	1,131.40	-1894.290	111.538	5981.730
133	162.068	11.490	6010.630	1,124.64	-1887.620	109.615	5979.810
137	169.266	12.020	7160.390	1,168.12	-1974.290	111.538	6199.040
141	170.132	12.940	10979.700	1,185.51	-2080.000	111.538	6317.310
145	169.865	13.930	18207.700	1,190.34	-2187.620	108.654	6394.230
149	171.198	14.940	23937.200	1,207.73	-2373.330	109.615	6500.000
153	168.199	16.030	29317.900	1,187.44	-2088.570	105.769	6535.580
157	161.935	16.650	29510.100	1,137.20	-591.429	103.846	6447.120
161	160.669	17.890	29308.200	1,141.06	723.810	103.846	6432.690
165	158.27	19.010	29283.100	1,129.47	764.762	102.885	6403.850
169	159.336	20.080	29400.000	1,129.47	778.095	100.962	6409.620
173	154.671	20.190	29339.100	1,109.18	771.429	101.923	6361.540
177	153.405	20.190	29320.800	1,104.35	752.381	719.231	6345.190
181	160.402	21.050	29512.100	1,136.23	529.524	725.000	6410.580
185	160.536	22.150	29893.700	1,133.33	485.714	728.846	6404.810
189	160.136	23.250	30067.600	1,122.71	419.048	730.769	6384.620
193	156.537	23.790	30054.100	1,106.28	415.238	734.615	6340.380
197	154.272	23.810	30037.700	1,085.99	412.381	734.615	6311.540

201	153.005	23.820	30014.500	1,084.06	411.429	737.500	6292.310
205	145.009	23.940	29940.100	1,032.85	381.905	736.538	6186.540
209	141.877	24.000	29909.200	1,011.59	371.429	736.538	6142.310
213	140.677	24.010	29891.800	1,001.93	372.381	736.538	6122.120
217	139.811	24.020	29879.200	998.07	368.571	736.538	6106.730
221	139.078	24.030	29869.600	992.27	371.429	737.500	6096.150
225	138.611	24.040	29858.900	989.37	361.905	737.500	6087.500
229	138.278	24.040	29855.100	986.47	363.810	738.462	6079.810
233	137.878	24.040	29846.400	984.54	360.952	741.346	6075.000
237	137.545	24.040	29839.600	982.61	360.952	742.308	6070.190
241	137.278	24.040	29836.700	981.64	357.143	743.269	6065.380
245	137.078	24.040	29834.800	979.71	353.333	743.269	6061.540
249	79.7014	21.980	29008.700	621.26	384.762	724.038	4955.770
253	39.3842	19.920	28252.200	454.11	390.476	707.692	3869.230
257	16.66	18.570	27783.600	389.37	396.190	696.154	3154.810
261	11.3954	18.170	27658.000	371.01	397.143	695.192	2950.960
265	6.19752	17.800	27546.900	367.15	397.143	692.308	2784.620
269	2.59896	17.480	27442.500	363.29	391.429	693.269	2654.810
273	0.79968	17.270	27396.100	354.59	392.381	690.385	2580.770
277	0	17.160	27358.500	364.25	393.333	693.269	2534.620
281	0	17.120	27359.400	353.62	391.429	693.269	2517.310
285	0	17.100	27355.600	358.45	391.429	694.231	2505.770
286	0	17.100	27351.700	358.45	392.381	695.192	2501.920

DATA UJI GESER BALOK SBG-1

NO	LOAD	LVDT 1	LVDT 2	LVDT	LVDT 3	SG TARIK	SG GESER	SG BETON TEKAN	SG FRP 1	SG FRP 2
2	0.000	0.020	0.000	0.000	0.000	0.000	0.966	0.000	0.000	1.923
4	0.000	-0.030	0.000	0.000	0.000	-2.899	6.763	-0.952	1.923	1.923
5	0.000	-0.010	0.010	-0.010	0.000	-0.966	9.662	0.000	3.846	0.962
7	0.000	-0.020	0.000	0.000	0.000	-1.932	8.696	-0.952	1.923	0.000
8	0.267	-0.030	0.000	0.000	0.000	-1.932	5.797	-1.905	1.923	-0.962
11	0.800	-0.040	-0.020	0.020	-0.020	0.000	7.729	-4.762	1.923	-0.962
14	1.599	-0.110	-0.050	0.050	-0.050	0.000	15.459	-7.619	0.962	-0.962
17	2.666	-0.110	-0.090	0.090	-0.080	6.763	5.797	-15.238	0.962	-0.962
20	3.865	-0.170	-0.140	0.140	-0.130	12.560	5.797	-20.000	0.962	-1.923
23	5.398	-0.220	-0.190	0.190	-0.180	18.358	3.865	-28.571	0.000	-0.962
25	6.531	-0.260	-0.230	0.230	-0.220	17.391	4.831	-34.286	0.962	0.962
28	8.397	-0.310	-0.290	0.290	-0.280	29.952	0.966	-43.810	0.000	1.923
31	9.996	-0.390	-0.340	0.340	-0.330	29.952	5.797	-53.333	0.000	1.923
34	11.062	-0.400	-0.370	0.370	-0.360	38.647	4.831	-60.000	-0.962	1.923
37	12.262	-0.370	-0.410	0.410	-0.390	44.444	0.966	-65.714	0.000	0.962
40	16.593	-0.500	-0.530	0.530	-0.510	96.618	-3.865	-96.191	-1.923	1.923
42	18.659	-0.610	-0.600	0.600	-0.570	125.604	3.865	-111.429	-1.923	2.885
45	22.324	-0.720	-0.710	0.710	-0.680	184.541	1.932	-142.857	-1.923	3.846
47	25.123	-0.730	-0.810	0.810	-0.760	228.019	0.966	-166.667	-1.923	3.846
52	32.454	-1.030	-1.100	1.100	-1.030	396.135	-1.932	-240.952	-2.885	6.731
57	41.117	-1.320	-1.530	1.530	-1.370	538.164	18.358	-312.381	-4.808	7.692
62	50.247	-1.790	-1.900	1.900	-1.770	656.039	-20.290	-400.000	-5.769	12.500
67	60.776	-2.090	-2.350	2.350	-2.170	826.087	12.560	-473.333	-9.615	11.539
72	71.505	-2.560	-2.890	2.890	-2.700	967.150	18.358	-559.048	-10.577	27.885
75	78.035	-2.960	-3.230	3.230	-2.970	1060.870	34.783	-609.524	-11.539	42.308
77	83.167	-3.140	-3.490	3.490	-3.190	1140.100	56.039	-642.857	-12.500	55.769
80	90.697	-3.510	-3.830	3.830	-3.500	1248.310	75.362	-703.810	-17.308	65.385
82	95.695	-3.690	-4.070	4.070	-3.720	1330.430	111.111	-738.095	-24.039	91.346
85	103.692	-4.090	-4.460	4.460	-4.080	1427.050	138.164	-801.905	-26.923	136.538
87	108.623	-4.350	-4.690	4.690	-4.320	1491.790	166.184	-838.095	-28.846	184.615
90	116.887	-4.680	-5.100	5.100	-4.660	1600.970	213.527	-897.143	-35.577	306.731
95	130.414	-5.280	-5.760	5.760	-5.280	1776.810	312.077	-1000.000	-43.269	345.192
98	138.478	-5.600	-6.190	6.190	-5.680	1905.310	424.155	-1057.140	-40.385	665.385
100	143.143	-5.820	-6.470	6.470	-5.940	1963.290	462.802	-1100.000	49.039	750.962
107	155.604	-6.870	-7.560	7.560	-6.890	2249.280	604.831	-1260.000	59.615	902.885
108	153.339	-7.040	-7.830	7.830	-7.130	2217.390	598.068	-1286.670	59.615	884.615
109	154.272	-7.210	-8.040	8.040	-7.290	2230.920	602.899	-1316.190	59.615	877.885
113	157.204	-7.870	-8.950	8.950	-8.050	2262.800	619.324	-1472.380	61.539	854.808
119	158.203	-8.870	-10.350	10.350	-9.160	2264.730	629.952	-1729.520	68.269	821.154
120	159.270	-9.050	-10.560	10.560	-9.370	2276.330	635.749	-1771.430	69.231	819.231
125	156.471	-10.120	-11.720	11.720	-10.180	2252.170	629.952	-1828.570	69.231	792.308
128	158.003	-10.750	-12.350	12.350	-10.650	2260.870	633.816	-1867.620	73.077	785.577
132	158.203	-11.600	-13.440	13.440	-11.350	2827.050	635.749	-1949.520	73.077	775.000
135	158.537	-12.210	-14.260	14.260	-11.880	12327.500	636.715	-2027.620	72.115	769.231
140	161.802	-13.250	-15.460	15.460	-12.690	3431.880	651.208	-2128.570	75.000	768.269
141	161.469	-13.480	-15.740	15.740	-12.870	3372.950	651.208	-2148.570	75.962	765.385
143	159.869	-13.930	-16.240	16.240	-13.190	3259.900	638.647	-2182.860	74.039	756.731
144	160.469	-14.100	-16.470	16.470	-13.350	3230.920	648.309	-2214.290	75.962	754.808
149	163.401	-15.190	-17.600	17.600	-14.100	3041.550	653.140	-2366.670	77.885	752.885
151	163.734	-15.550	-18.060	18.060	-14.410	3031.880	659.903	-2412.380	78.846	751.923
155	164.468	-16.350	-19.020	19.020	-15.150	3000.000	663.768	-2479.050	79.808	749.038
156	164.401	-16.530	-19.280	19.280	-15.350	2987.440	664.734	-2493.330	79.808	748.077
157	163.734	-16.640	-19.540	19.540	-15.550	2981.640	662.802	-2691.430	80.769	742.308
161	162.535	-17.400	-20.630	20.630	-16.340	2972.950	664.734	-2680.000	82.692	731.731
165	160.869	-17.880	-21.250	21.250	-16.750	2977.780	655.072	-1831.430	81.731	724.038
168	157.670	-18.390	-22.050	22.050	-17.220	2975.850	649.275	-642.857	82.692	713.462
173	152.072	-18.530	-22.160	22.160	-17.240	2964.250	643.478	-373.333	80.769	696.154
175	151.140	-18.500	-22.160	22.160	-17.250	2947.830	623.188	-357.143	80.769	693.269
178	150.207	-18.450	-22.190	22.190	-17.230	2958.450	634.783	-304.762	78.846	688.462
181	149.474	-18.430	-22.190	22.190	-17.230	2955.560	622.222	-262.857	80.769	685.577
184	148.874	-18.440	-22.190	22.190	-17.230	2948.790	630.918	-245.714	79.808	681.731
186	148.541	-18.440	-22.190	22.190	-17.220	2951.690	629.952	-236.190	79.808	680.769
189	147.141	-18.430	-22.210	22.210	-17.220	2948.790	628.019	-173.333	78.846	675.000
192	146.475	-18.420	-22.210	22.210	-17.220	2944.930	623.188	-156.190	78.846	673.077
195	146.075	-18.440	-22.210	22.210	-17.220	2943.000	627.053	-141.905	78.846	671.154
197	145.808	-18.410	-22.210	22.210	-17.220	2943.000	622.222	-139.048	79.808	669.231
198	145.808	-18.430	-22.220	22.220	-17.220	2943.960	625.121	-138.095	78.846	668.269
201	145.408	-18.420	-22.210	22.210	-17.210	2939.130	620.290	-131.429	79.808	667.308
204	145.075	-18.430	-22.220	22.220	-17.200	2939.130	621.256	-130.476	79.808	665.385
208	123.884	-17.900	-21.610	21.610	-16.650	2909.180	571.981	-119.048	75.000	603.846
212	67.173	-15.870	-19.340	19.340	-14.660	2898.550	400.000	-109.524	59.615	340.385
213	55.778	-15.450	-18.850	18.850	-14.210	2900.480	370.048	-108.571	56.731	277.885

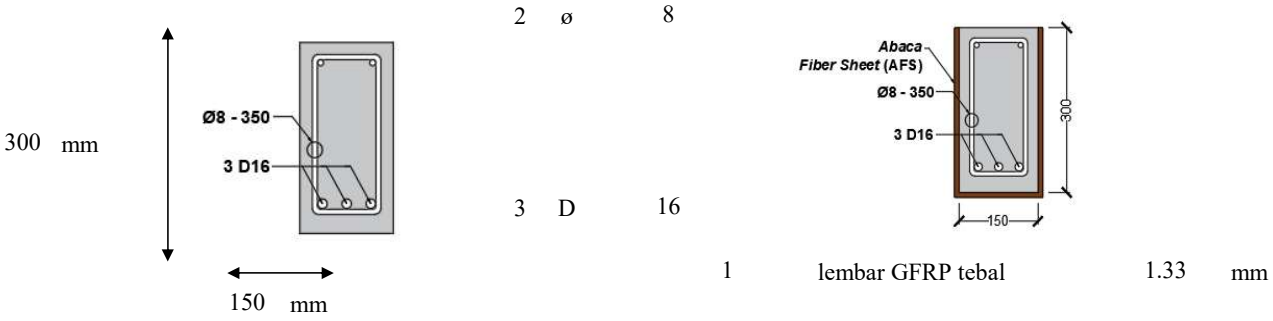
214	45.515	-15.010	-18.380	18.380	-13.780	2905.310	346.860	-106.667	54.808	220.192
215	36.519	-14.620	-17.940	17.940	-13.390	2906.280	327.536	-105.714	51.923	169.231
216	28.922	-14.270	-17.550	17.550	-13.050	2914.010	314.976	-107.619	50.962	127.885
223	0.000	-12.570	-15.710	15.710	-11.470	2921.740	257.971	-118.095	47.115	-10.577
224	-0.333	-12.530	-15.700	15.700	-11.440	2928.500	263.768	-118.095	46.154	-10.577
225	0.000	-12.560	-15.680	15.680	-11.450	2920.770	257.971	-116.190	47.115	-8.654
227	0.000	-12.450	-15.660	15.660	-11.430	2919.810	256.039	-116.190	47.115	-8.654

Analisis Teoritis Perkuatan Geser Balok ACI 440 DESAIN RENCANA

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif GFRP	d_{fv}	=	301	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	d'	=	30	mm
Kuat tekan beton	f'_c	=	25.6	N/mm^2
Modulus elastisitas beton				
$E_c = 4700\ f'^{0.5}_c$				
$= 4700 \cdot 25.6^{0.5}$	E_c	=	23780.3	N/mm^2
Kuat leleh tulangan geser	f_y	=	280	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan GFRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang GFRP



Data material GFRP

Ketebalan per lembaran	t_f	=	**1.33**	mm
Kuat tarik ultimit	f^*_{fu}	=	**460**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.02**	mm/mm
Modulus elastisitas	E_f	=	**20900**	N/mm^2
Jumlah lapisan GFRP	n	=	**1**	
Sudut pemasangan GFRP		=	**90**	
Jarak pemasangan GFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	280	N/mm^2
Regangan leleh	ε_y	=	0.0014	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Material yang digunakan : **GFRP**

Lokasi balok berada di **Interior**

sehingga digunakan

C_E = **0.75**

f_{fu} = C_E f^*_{fu}

= 0.75 . 460

= 345 N/mm^2

ε_{fu} = C_E ε^*_{fu}

= 0.75 . 0.02

= 0.015 mm/mm

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang

V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton

V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} b d$$

$$= \frac{1}{6} . 25.6^{0.5} . 150 . 262$$

V_c = 33140.67 N (33.14 kN)

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v f_y d}{s}$$

A_v = 100.480

= 100.480 mm^2

$$= \frac{100 . 280 . 262}{350}$$

$V_{s\,eks}$ = 21060.61 N (21.06 kN)

Maka kuat geser nominal

$V_n = V_c + V_s$

= 33.14 + 21.06

V_n = 54.20 kN

Kuat geser akibat GFRP

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi (V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

V_n = 0.75 (Vc + Vs + 0.85 V_f

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat

lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP, ACI Committee Report 440 memberikan persamaan :

$$V_f = \frac{A_f \quad f_{fe} \quad (Sin\ \beta + Cos\ \beta) \quad d_f}{s_f}$$

Regangan efektif *FRP*

$$\varepsilon_{fe} = k_v \quad \varepsilon_{fu} \leq 0.004$$

Tegangan efektif *FRP*

$$f_{fe} = \varepsilon_{fe} \quad E_f$$

Luas perkuatan FRP

$$A_f = 2 \quad n \quad t_f \quad w_f$$

Dari persamaan regangan efektif *FRP* (εfe), koefisien reduksi dapat dihitung menggunakan persamaan :

$$K_v = \left(\frac{k_1 \quad k_2 \quad L_e}{11900 \quad \varepsilon_{fu}}\right)$$

$$k_1 = \left(\frac{f'c}{27}\right)^{2/3}$$

$$\left(\frac{d_f \quad - \quad 2L_e}{d_f}\right)$$ untuk rekatan pada kedua sisi

$$k_2 = \left(\frac{d_f \quad - \quad Le}{d_f}\right)$$ untuk rekatan yang berbentuk U

$$L_e = \frac{23300}{(n \quad x \quad t_f \quad x \quad E_f)^{0.58}}$$

Menentukan regangan efektif dari perkuatan FRP

$$\varepsilon_{fe} = k_v \quad \varepsilon_{fu} \leq 0.004$$

Dari persamaan regangan efektif *FRP* (εfe), koefisien reduksi dapat dihitung menggunakan persamaan :

$$K_v = \left(\frac{k_1 \quad k_2 \quad L_e}{11900 \quad \varepsilon_{fu}}\right)$$

dimana:

$$k_1 = \left(\frac{f'c}{27}\right)^{2/3} = \left(\frac{25.6}{27}\right)^{2/3} = 0.97$$

$$k_2 = \left(\frac{d_{fv} \quad - \quad Le}{d_{fv}}\right)$$ untuk rekatan berbentuk U

dimana: $Le = \frac{23300}{(n \quad x \quad t_f \quad x \quad E_f)^{0.58}}$

$$L_e = \frac{23300}{(1 \quad x \quad 1.33 \quad x \quad 20900)^{0.58}} = 61.64$$

Maka:

$$k_2 = \left(\frac{d_{fv} - L_e}{d_{fv}}\right) = \left(\frac{301.0 - 61.64}{301.0}\right) = 0.80$$

Maka:

$$K_v = \left(\frac{k1 \quad k2 \quad L_e}{11900 \times \varepsilon_{fu}}\right) = \left(\frac{0.97 \times 0.80 \times 61.64}{11900.00 \times 0.015}\right) = 0.265 \leq 0.75$$

Maka Regangan Efektif (ε_{fe}):

$$\varepsilon_{fe} = k_v \quad \varepsilon_{fu} \leq 0.004$$
$$= 0.2650 \times 0.015 = 0.00398 \leq 0.004$$

ε_{fe} = **0.003975**

Menentukan tegangan efektif dari perkuatan FRP

$$f_{fe} = \varepsilon_{fe} \quad E_f$$
$$= 0.0039753 \; . \; 20900$$
$$= 83.08$$

$$A_f = 2 \; . \; 1 \; . \; 1.33 \; . \; 700$$
$$= 1862.00 \; mm^2$$

$$V_f = \frac{A_f \quad f_{fe} \quad (Sin\beta + \cos\beta) \quad d_f}{s_f}$$

$$= \frac{1862.00 \; . \; 83.08 \; . \; (\sin 90 + \cos 90) \; 301.0}{700}$$

$$V_f = \mathbf{66001.024 \; N}$$
$$= \mathbf{66.00 \; kN}$$

Maka kuat geser total

$$V_n = V_c + V_s + V_f$$
$$= 33.14 + 21.06 + 66.00$$
$$V_n = \mathbf{120.20 \; kN}$$

Analisis Teoritis Perkuatan Geser Balok ACI 440 HASIL EKSPERIMENTAL

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif GFRP	d_{fv}	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	d'	=	30	mm
Kuat tekan beton	f'_c	=	21.1	N/mm^2

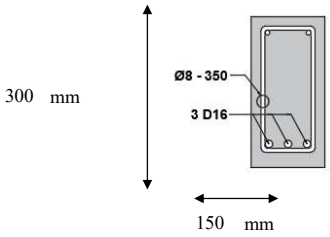
Modulus elastisitas beton

$E_c = 4700\ f'^{0.5}_c$

$= 4700 \cdot 21.1^{0.5}$ → $E_c = 21589.3$ N/mm

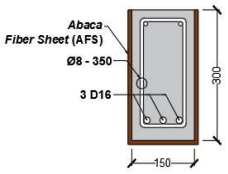
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan GFRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang GFRP



2 ø 8

3 D 16



1 lembar GFRP tebal 1.33 mm

Data material GFRP

Ketebalan per lembaran	t_f	=	**1.33**	mm
Kuat tarik ultimit	f^*_{fu}	=	**460**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.02**	mm/mm
Modulus elastisitas	E_f	=	**20900**	N/mm^2
Jumlah lapisan GFRP	n	=	**1**	
Sudut pemasangan GFRP		=	**90**	
Jarak pemasangan GFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Material yang digunakan : **GFRP**

Lokasi balok berada di **Interior**

sehingga digunakan

C_E = **0.75**

$f_{fu} = C_E \cdot f^*_{fu}$

$= 0.75 \cdot 460$

$= 345\ N/mm^2$

$\varepsilon_{fu} = C_E \cdot \varepsilon^*_{fu}$

$= 0.75 \cdot 0.02$

$= 0.015$ mm/mm

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang

V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton

V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$$

$$= \frac{1}{6} \cdot 21.1^{0.5} \cdot 150 \cdot 262$$

V_c = 30087.25 N (30.09 kN)

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$$

A_v = 100.480

= 100.480 mm^2

$$= \frac{100.48 \cdot 336.8 \cdot 262}{350}$$

$V_{s\,eks}$ = 25331.40 N (25.33 kN)

Maka kuat geser nominal

$V_n = V_c + V_s$

= 30.09 + 25.33

V_n = 55.42 kN

Kuat geser akibat GFRP

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi(V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$$V_n = 0.75 \; (Vc + Vs + 0.85 \; V_f$$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP, ACI Committee Report 440 memberikan persamaan :

$$V_f = \frac{A_f \; f_{fe} \; (Sin\,\beta + Cos\,\beta) \; d_f}{s_f}$$

Regangan efektif *FRP*

$$\varepsilon_{fe} = k_v \; \varepsilon_{fu} \leq 0.004$$

Tegangan efektif *FRP*

$$f_{fe} = \varepsilon_{fe} \; E_f$$

Luas perkuatan FRP

$$A_f = 2 \; n \; t_f \; w_f$$

Dari persamaan regangan efektif *FRP* (εfe), koefisien reduksi dapat dihitung menggunakan persamaan :

$$K_v = \left(\frac{k_1 \; k_2 \; L_e}{11900 \; \varepsilon_{fu}} \right)$$

$$k_1 = \left(\frac{f'c}{27} \right)^{2/3}$$

$$\left(\frac{d_f - 2L_e}{d_f} \right)$$ untuk rekatan pada kedua sisi

$$k_2 = \left(\frac{d_f - Le}{d_f} \right)$$ untuk rekatan yang berbentuk U

$$L_e = \frac{23300}{(n \times t_f \times E_f)^{0.58}}$$

Menentukan regangan efektif dari perkuatan FRP

$$\varepsilon_{fe} = k_v \varepsilon_{fu} \leq 0.004$$

Dari persamaan regangan efektif *FRP* (εfe), koefisien reduksi dapat dihitung menggunakan persamaan :

$$K_v = \frac{k_1 \; k_2 \; L_e}{11900 \; \varepsilon_{fu}}$$

dimana:

$$k_1 = \left(\frac{f'c}{27}\right)^{2/3} = \left(\frac{21.1}{27}\right)^{2/3} = 0.85$$

$$k_2 = \left(\frac{d_{fv} - Le}{d_{fv}}\right)$$ untuk rekatan berbentuk U dimana: $Le = \frac{23300}{(n \times t_f \times E_f)^{0.58}}$

$$L_e = \frac{23300}{(1 \times 1.33 \times 20900)^{0.58}} = 61.64$$

Maka:

$$k_2 = \left(\frac{d_{fv} - L_e}{d_{fv}}\right) = \left(\frac{262.0 - 61.64}{262.0}\right) = 0.76$$

Maka:

$$K_v = \left(\frac{k1 \; k2 \; L_e}{11900 \times \varepsilon_{fu}}\right) = \left(\frac{0.85 \times 0.76 \times 61.64}{11900.00 \times 0.015}\right) = 0.224 \leq 0.75$$

Maka Regangan Efektif (ε_{fe}):

$$\varepsilon_{fe} = k_v \; \varepsilon_{fu} \leq 0.004$$
$$= 0.2240 \times 0.015 = 0.00336 \leq 0.004$$

ε_{fe} = **0.003361**

Menentukan tegangan efektif dari perkuatan FRP

$$f_{fe} = \varepsilon_{fe} \; E_f$$
$$= 0.00336063 \; . \; 20900$$
$$= 70.24$$

$$A_f = 2 \; . \; 1 \; . \; 1.33 \; . \; 700$$
$$= 1862.00 \; mm^2$$

$$V_f = \frac{A_f \; f_{fe} \; (Sin\beta + \cos\beta) \; d_f}{s_f}$$

$$= \frac{1862.00 \; . \; 70.24 \; . \; (\sin 90 + \cos 90) \; 262.0}{700}$$

V_f = **48566.8265 N**
= **48.57 kN**

Maka kuat geser total

$$V_n = V_c + V_s + V_f$$
$$= 30.09 + 25.33 + 48.57$$

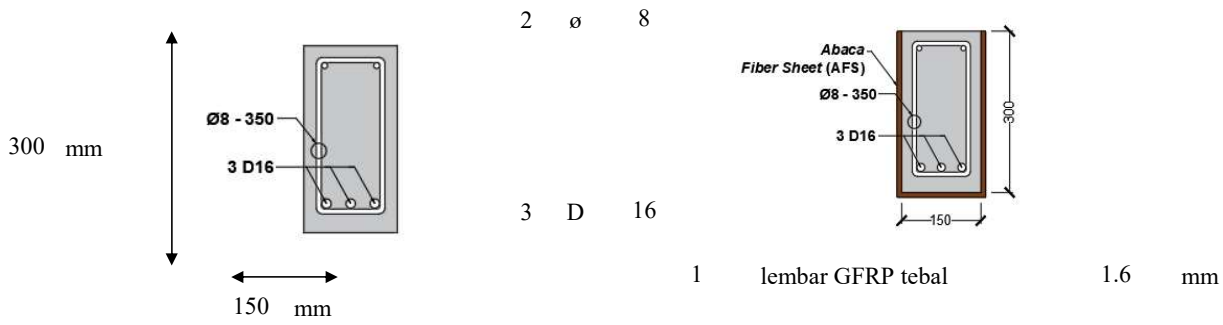
V_n = **103.99 kN**

Analisis Teoritis Perkuatan Geser Balok ACI 440 TEORITIS DARI HASIL EKSPERIMENTAL

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar NFRP	w_f	=	700	mm
Tinggi efektif NFRP	d_{fv}	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	d'	=	34	mm
Kuat tekan beton	f'_c	=	21.1	N/mm^2
Modulus elastisitas beton				
$E_c = 4700\ f'^{0.5}_c$				
$= 4700 \cdot 21.1^{0.5}$	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan FRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang NFRP



1 lembar GFRP tebal 1.6 mm

Data material NFRP

Ketebalan per lembaran	t_f	=	**1.60**	mm
Kuat tarik ultimit	f^*_{fu}	=	**67.34**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.013**	mm/mm
Modulus elastisitas	E_f	=	**5009**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Material yang digunakan : **AFS**

Lokasi balok berada di **Interior**

sehingga digunakan

C_E = **0.75**

f_{fu} = C_E f^*_{fu}

= 0.75 . 67.3360488

= 50.50203662 N/mm^2

ε_{fu} = C_E ε^*_{fu}

= 0.75 . 0.013442

= 0.0100815 mm/mm

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang

V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton

V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} b d$$

$$= \frac{1}{6} . 21.1^{0.5} . 150 . 262$$

V_c	**=**	**30087.25**	**N**	**(**	**30.09**	**kN)**

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v f_y d}{s}$$

$$= \frac{100 . 336.8 . 262}{350}$$

A_v = 100.480

= 100.480 mm^2

$V_{s\,eks}$	**=**	**25331.40**	**N**	**(**	**25.33**	**kN)**

Maka kuat geser nominal

$V_n = V_c + V_s$

= 30.09 + 25.33

V_n = 55.42 kN

Kuat geser akibat GFRP

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi (V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

V_n = 0.75 (Vc + Vs + 0.85 V_f

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat

lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP, ACI Committee Report 440 memberikan persamaan :

$$V_f = \frac{A_f \quad f_{fe} \quad (Sin\ \beta + Cos\ \beta) \quad d_f}{s_f}$$

Regangan efektif *FRP*

$$\varepsilon_{fe} = k_v \quad \varepsilon_{fu} \leq 0.004$$

Tegangan efektif *FRP*

$$f_{fe} = \varepsilon_{fe} \quad E_f$$

Luas perkuatan FRP

$$A_f = 2 \quad n \quad t_f \quad w_f$$

Dari persamaan regangan efektif *FRP* (εfe), koefisien reduksi dapat dihitung menggunakan persamaan :

$$K_v = \left(\frac{k_1 \quad k_2 \quad L_e}{11900 \quad \varepsilon_{fu}}\right)$$

$$k_1 = \left(\frac{f'c}{27}\right)^{2/3}$$

$$\left(\frac{d_f \quad - \quad 2L_e}{d_f}\right)$$ untuk rekatan pada kedua sisi

$$k_2 = \left(\frac{d_f \quad - \quad Le}{d_f}\right)$$ untuk rekatan yang berbentuk U

$$L_e = \frac{23300}{\left(n \quad x \quad t_f \quad x \quad E_f\right)^{0.58}}$$

<u>Menentukan regangan efektif dari perkuatan Abaca</u>

$$\varepsilon_{fe} = k_v \quad \varepsilon_{fu} \leq 0.004$$

Dari persamaan regangan efektif AFS (εfe), koefisien reduksi dapat dihitung menggunakan persamaan :

$$K_v = \left(\frac{k_1 \quad k_2 \quad L_e}{11900 \quad \varepsilon_{fu}}\right)$$

dimana:

$$k_1 = \left(\frac{f'c}{27}\right)^{2/3} = \left(\frac{21.1}{27}\right)^{2/3} = 0.85$$

$$k_2 = \left(\frac{d_{fv} \quad - \quad Le}{d_{fv}}\right)$$ untuk rekatan berbentuk U dimana: $Le = \frac{23300}{\left(n \quad x \quad t_f \quad x \quad E_f\right)^{0.58}}$

$$L_e = \frac{23300}{(1 \times 1.6 \times 5009.377238)^{0.58}} = 126.79$$

Maka:

$$k_2 = \left(\frac{d_{fv} - L_e}{d_{fv}}\right) = \left(\frac{262.0 - 126.79}{262.0}\right) = 0.52$$

Maka:

$$K_v = \left(\frac{k1 \; k2 \; L_e}{11900 \times \varepsilon_{fu}}\right) = \left(\frac{0.85 \times 0.52 \times 126.79}{11900.00 \times 0.01}\right) = 0.463 \leq 0.750$$

Maka Regangan Efektif (ε_{fe}):

$$\varepsilon_{fe} = k_v \; \varepsilon_{fu} \leq 0.004$$
$$= 0.4627 \times 0.010 = 0.005 \leq 0.004$$

ε_{fe} = 0.004000

Menentukan tegangan efektif dari perkuatan Abaca

$$f_{fe} = \varepsilon_{fe} \; E_f$$
$$= 0.004 \; . \; 5009$$
$$= 20.04$$

$$A_f = 2 \; . \; 1 \; . \; 1.6 \; . \; 700$$
$$= 2240.00 \; mm^2$$

$$V_f = \frac{A_f \; f_{fe} \; (Sin\beta + \cos\beta) \; d_f}{s_f}$$
$$= \frac{2240.00 \; . \; 20.04 \; . \; (\sin 90 + \cos 90) \; 262.0}{700}$$

V_f = 16668.07 N
= 16.67 kN

Maka kuat geser total

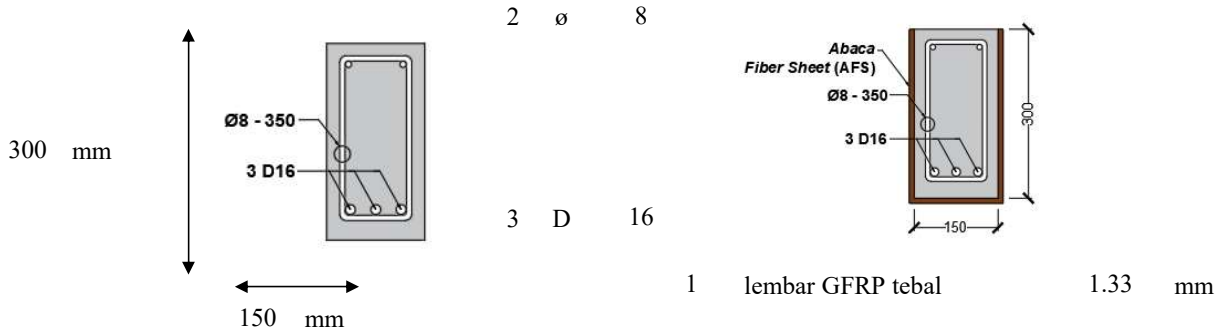
$$V_n = V_c + V_s + V_f$$
$$= 30.09 + 25.33 + 16.67$$
V_n = 72.09 kN

Analisis Teoritis Perkuatan Geser Balok FIB 14 TEORITIS DARI HASIL EKPERIMENTAL

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif NFRP	h_f	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	df	=	34	mm
Kuat tekan beton	f_{cm}	=	21.1	N/mm^2
Modulus elastisitas beton				
$E_c = 4700 \; f'^{0.5}_c$				
$= 4700 \; . \; 21.1^{0.5}$	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan FRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang NFRP



1 lembar GFRP tebal 1.33 mm

Data material NFRP

Ketebalan per lembaran	t_f	=	**1.33**	mm
Kuat tarik ultimit	f_{fbk}	=	**67.34**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.013**	mm/mm
Modulus elastisitas	E_f	=	**5009**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Material yang digunakan : **AFS**
Lokasi balok berada di **Interior**

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang
V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton
V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$$

$$= \frac{1}{6} \; . \; 21.1^{0.5} \; . \; 150 \; . \; 262$$

V_c = 30087.25 N (30.09 kN)

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$$

$$= \frac{100.5 \; . \; 336.78 \; . \; 262}{350}$$

A_v = 100.480
= 100.480 mm^2

$V_{s\,eks}$ = 25331.40 N (25.33 kN)

Maka kuat geser nominal

$V_n = V_c + V_s$
= 30.09 + 25.331
V_n = 55.42 kN

Kuat geser akibat AFS

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi (V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$$V_n = 0.75 \; (Vc + Vs + 0.85 \; V_f)$$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP,

fib bulletin 14. Externally applied FRP reinforcement for concrete structures. fib Task Group 5.1, Lausanne, Switzerlan

$$V_{Rd,f} = 0.9 \quad \varepsilon_{f,e} \; E_f \; \rho_f \quad b \quad d \quad \left(\cot\theta + \cot\beta\right) \sin\beta$$

Dimana,

$$\varepsilon_{f,e} = 0.17 \left(\frac{f_c^{\,2/3}}{E_f \; \rho_f}\right)^{0.3} \varepsilon_{fu} \qquad , \quad \rho_f = 2 \quad t_f \; \frac{\sin\alpha}{b_w} = 2 \quad t_f \; \frac{\sin 90}{b_w}$$

$$= 0.0177$$

untuk U-Wrap

$$\varepsilon_{f,e} = \min \left\{ 0.17 \left(\frac{f_{cm}^{\,2/3}}{E_f \quad \rho_f}\right)^{0.3} \varepsilon_{fu} \quad , \quad 0.65 \left(\frac{f_{cm}^{\,2/3}}{E_f \quad \rho_f}\right)^{0.56} 10^{-3} \right\}$$

(fracture) (peeling-off)

$$\varepsilon_{f,e} = \min \left\{ \begin{array}{l} 0.17 \left(\dfrac{21.1^{\,2/3}}{5009 \quad . \quad 0.01773}\right)^{0.3} \quad 0.013 \\ 0.65 \left(\dfrac{21.1^{\,2/3}}{5009 \quad . \quad 0.01773}\right)^{0.56} \quad 0.001 \end{array} \right\}$$

$$\varepsilon_{f,e} = \min \left\{ 0.0011 \quad , \quad 0.00016 \right\}$$

$$V_{Rd,f} = 0.9 \quad \varepsilon_{f,e} \; E_f \; \rho_f \quad b \quad d \quad \left(\cot\theta + \cot\beta\right) \sin\beta$$

$$V_{Rd,f} = 0.9 \quad \varepsilon_{f,e} \; E_f \; \rho_f \quad b \quad d \quad \left(\cot 36 \quad + \quad \cot 45\right) \quad \sin 45$$

$$V_{Rd,f} = 0.9 \quad . \quad 0.00109 \quad . \quad 5009 \quad . \quad 0.0177 \quad . \quad 150 \quad . \quad 262 \quad . \quad \left(1 \quad + \quad 1\right) \quad 1$$

$$V_{Rd,f} = 5778.40$$

$$= \mathbf{5778.40} \quad \mathbf{N}$$

$$= 5.78 \quad \mathbf{kN}$$

Maka kuat geser total

$$V_n = V_c + V_s + V_f$$

$$= 30.09 + 25.33 + 5.78$$

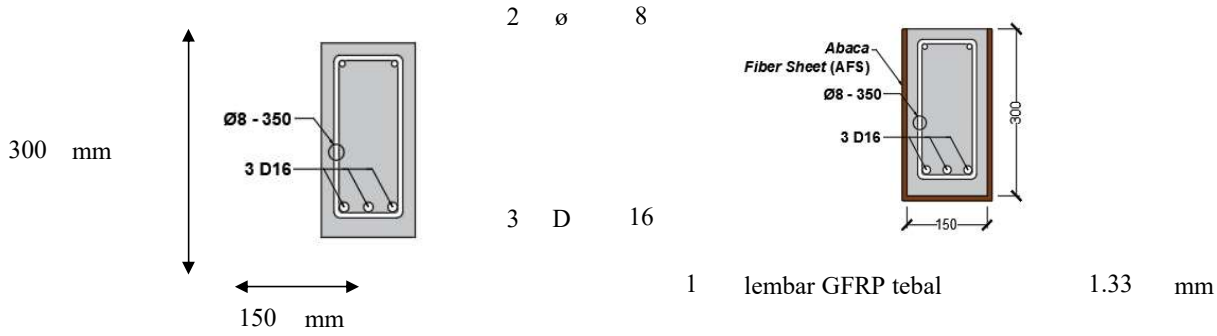
$$\mathbf{V_n = 61.20 \; kN}$$

Analisa Teoritis Perkuatan Geser Balok dengan GFRP

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif NFRP	h_f	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	df	=	34	mm
Kuat tekan beton	f_{cm}	=	21.1	N/mm^2
Modulus elastisitas beton				
$E_c = 4700\ f'^{0.5}_c$				
$= 4700 \cdot 21.1^{0.5}$	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan FRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang GFRP



1 lembar GFRP tebal 1.33 mm

Data material NFRP

Ketebalan per lembaran	t_f	=	**1.33**	mm
Kuat tarik ultimit	f_{fbk}	=	**460.00**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.02**	mm/mm
Modulus elastisitas	E_f	=	**20900**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Material yang digunakan : **AFS**
Lokasi balok berada di **Interior**

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang
V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton
V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$$

$$= \frac{1}{6} \; . \; 21.1^{0.5} \; . \; 150 \; . \; 262$$

V_c = 30087.25 N (30.09 kN)

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$$

$$= \frac{100.5 \; . \; 336.78 \; . \; 262}{350}$$

A_v = 100.480
= 100.480 mm^2

$V_{s\,eks}$ = 25331.40 N (25.33 kN)

Maka kuat geser nominal

$V_n = V_c + V_s$
= 30.09 + 25.331
V_n = 55.42 kN

Kuat geser akibat AFS

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi (V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$$V_n = 0.75 \left(Vc + Vs + 0.85\ V_f\right)$$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP,

fib bulletin 14. Externally applied FRP reinforcement for concrete structures. fib Task Group 5.1, Lausanne, Switzerlan

$$V_{Rd,f} = 0.9\ \varepsilon_{f,e}\ E_f\ \rho_f\ b\ d\ \left(\cot\theta + \cot\beta\right) \sin\beta$$

Dimana,

$$\varepsilon_{f,e} = 0.17 \left(\frac{f_c^{2/3}}{E_f\ \rho_f}\right)^{0.3} \varepsilon_{fu} \quad , \quad \rho_f = 2\ t_f\ \frac{\sin\alpha}{b_w} = 2\ t_f\ \frac{\sin 90}{b_w}$$

$$= 0.0177$$

untuk U-Wrap

$$\varepsilon_{f,e} = \min \left\{ 0.17 \left(\frac{f_{cm}^{2/3}}{E_f\ \rho_f}\right)^{0.3} \varepsilon_{fu} \ , \ 0.65 \left(\frac{f_{cm}^{2/3}}{E_f\ \rho_f}\right)^{0.56} 10^{-3} \right\}$$

(fracture) (peeling-off)

$$\varepsilon_{f,e} = \min \left\{ \begin{array}{ll} 0.17 \left(\frac{21.1^{2/3}}{20900\ .\ 0.01773}\right)^{0.3} & 0.020 \\ 0.65 \left(\frac{21.1^{2/3}}{20900\ .\ 0.01773}\right)^{0.56} & 0.001 \end{array} \right\}$$

$$\varepsilon_{f,e} = \min \left\{ 0.0011 \ , \ 0.00007 \right\}$$

$$V_{Rd,f} = 0.9\ \varepsilon_{f,e}\ E_f\ \rho_f\ b\ d\ \left(\cot\theta + \cot\alpha\right) \sin\alpha$$

$$V_{Rd,f} = 0.9\ \varepsilon_{f,e}\ E_f\ \rho_f\ b\ d\ \left(\cot 36 + \cot 45\right) \sin 45$$

$$V_{Rd,f} = 0.9\ .\ 0.00106\ .\ 20900\ .\ 0.0177\ .\ 150\ .\ 262\ .\ \left(1 + 1\right)\ 1$$

$$V_{Rd,f} = 23368.31$$

$$= \mathbf{23368.31}\ \mathbf{N}$$

$$= 23.37\ \mathbf{kN}$$

Maka kuat geser total

$$V_n = V_c + V_s + V_f$$

$$= 30.09 + 25.33 + 23.37$$

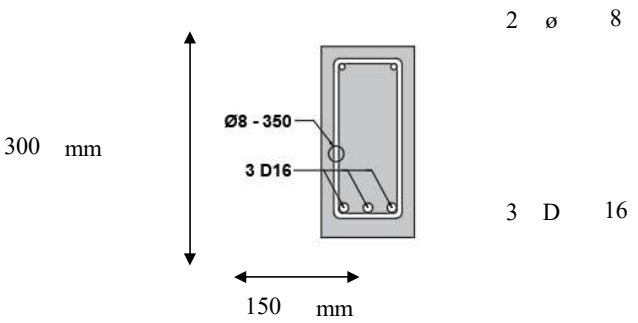
$$\mathbf{V_n = 78.79\ kN}$$

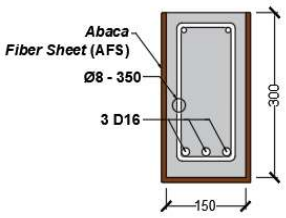
Analisis Teoritis Perkuatan Geser Balok TR 55 TEORITIS DARI HASIL EKSPERIMENTAL

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif GFRP	d_f	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	df	=	34	mm
Kuat tekan beton	f_{cm}	=	21.1	N/mm^2
Modulus elastisitas beton				
$E_c = 4700 \; f'_c{}^{0.5}$				
$= 4700 \; . \; 21.1^{0.5}$	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan GFRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang NFRP





1 lembar GFRP tebal 1.6 mm

Data material NFRP

Ketebalan per lembaran	t_f	=	**1.60**	mm
Kuat tarik ultimit	f_{fbk}	=	**67.34**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.013**	mm/mm
Modulus elastisitas	E_f	=	**5009**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang
V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton
V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$

$= \frac{1}{6} . \; 21.1^{0.5} . \; 150 . \; 262$

V_c	**=**	**30087.25**	**N**	**(**	**30.09**	**kN)**

Kekuatan geser Tulangan

$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$

$= \frac{100.48 . \; 336.78 . \; 262}{350}$

A_v = 100.480
= 100.480 mm^2

$V_{s\,eks}$	**=**	**25331.40**	**N**	**(**	**25.33**	**kN)**

Maka kuat geser nominal

$V_n = V_c + V_s$

$= 30.09 + 25.3314$

V_n = 55.42 kN

Kuat geser akibat AFS

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$\Phi V_n = \Phi (V_c + V_s + \Psi V_f)$ (1)

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$V_n = 0.75 \; (Vc + Vs + 0.85) \; V_f$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP, TR 55 Design guidance for strengthening concrete structures using fibre composite materials. Concrete Society, UK memberikan persamaan sebagai berikut

$V_{Rd.f} = \frac{A_{fw}}{s_f} \; d_f \; \frac{n_s}{3} \left(l_{tmax} \; \cos\beta \right) E_{fd} \; \varepsilon_{fse} \; \sin\beta + \cos\beta$

untuk U-wrap

n_s = 1

l_{tmax} = $0.7\sqrt{\frac{E_{fd}\ t_f}{f_{ctk}}}$; f_{ctk} = $0.21\ \left(f'c\right)^{2/3}$

= 1.60

Sehingga,

l_{tmax} = $0.7\sqrt{\frac{5009\ .\ 1.60}{1.60}}$

l_{tmax} = 49.49

Regangan efektif,

ε_{fse} = $\min\left(\frac{\varepsilon_{df}}{2}\ ,\ 0.5\sqrt{\frac{f_{ctk}}{E_{fd}\ t_f}}\ ,\ 0.004\right)$

ε_{fse} = min (0.007 , 0.007 , 0.004)

maka di ambil ε_{fse} = 0.0040

Sehingga,

$V_{Rd,f} = \frac{A_{fw}}{s_f}\left(d_f\ \frac{n_s}{3}\ l_{tmax}\ \cos\beta\right) E_{fd}\ \varepsilon_{fse}\ \sin\beta + \cos\beta$ A_{fw} = 2 . 700 . 1.60 = 2240

$V_{Rd,f} = \frac{A_{fw}}{s_f}\left(d_f\ -\ \frac{n_s}{3}\ l_{tmax}\ \cos 90\right) E_{fd}\ \varepsilon_{fse}\ \left(\sin 90 + \cos 90\right)$

$V_{Rd,f} = \frac{2240}{700}\ .\ \left(262\ -\ \frac{1}{3}\ 49.49\ .\ 0.0\right)\ 5009\ .\ 0.004\ .\ \left(1.0\ +\ 0.0\right)$

= **16799.45** **N**

= 16.80 **kN**

Maka kuat geser total

V_n = V_c + V_s + V_f

= 30.09 + 25.33 + 16.80

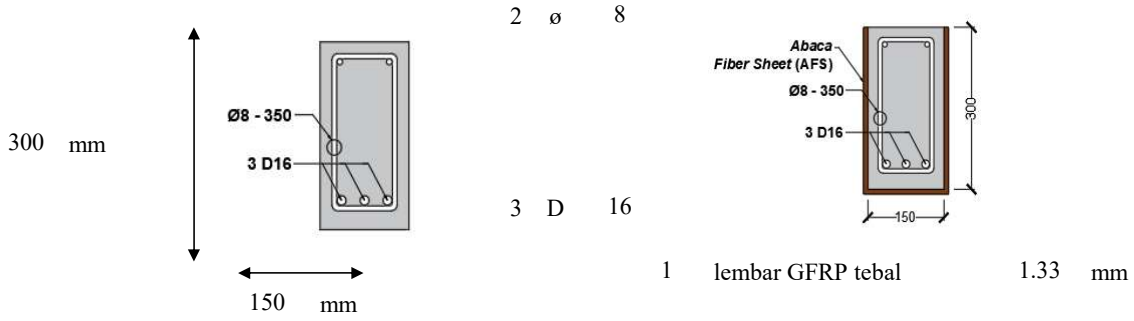
V_n = 72.22 kN

Analisa Teoritis Perkuatan Geser Balok dengan GFRP

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif GFRP	d_f	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	df	=	34	mm
Kuat tekan beton	f_{cm}	=	21.1	N/mm^2
Modulus elastisitas beton				
$E_c = 4700 \cdot f'^{0.5}_c$				
$= 4700 \cdot 21.1^{0.5}$	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan GFRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang GFRP



Data material NFRP

Ketebalan per lembaran	t_f	=	**1.33**	mm
Kuat tarik ultimit	f_{fbk}	=	**460.00**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.02**	mm/mm
Modulus elastisitas	E_f	=	**20900.00**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang
V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton
V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$

$= \frac{1}{6} . \; 21.1^{0.5} . \; 150 . \; 262$

V_c	**=**	**30087.25**	**N**	**(**	**30.09**	**kN)**

Kekuatan geser Tulangan

$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$

$= \frac{100.48 . \; 336.78 . \; 262}{350}$

A_v = 100.480
= 100.480 mm^2

$V_{s\,eks}$	**=**	**25331.40**	**N**	**(**	**25.33**	**kN)**

Maka kuat geser nominal

$V_n = V_c + V_s$

$= 30.09 + 25.3314$

V_n = 55.42 kN

Kuat geser akibat AFS

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$\Phi V_n = \Phi (V_c + V_s + \Psi V_f)$ (1)

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$V_n = 0.75 \; (Vc + Vs + 0.85) \; V_f$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP, TR 55 Design guidance for strengthening concrete structures using fibre composite materials. Concrete Society, UK memberikan persamaan sebagai berikut

$V_{Rd.f} = \frac{A_{fw}}{s_f} \; d_f \; \frac{n_s}{3} \left(l_{tmax} \; \cos\beta \right) E_{fd} \; \varepsilon_{fse} \; \sin\beta + \cos\beta$

untuk U-wrap

n_s = 1

l_{tmax} = $0.7\sqrt{\frac{E_{fd}\ t_f}{f_{ctk}}}$; f_{ctk} = $0.21\ \left(f'c\right)^{2/3}$

= 1.60

Sehingga,

l_{tmax} = $0.7\sqrt{\frac{20900\ .\ 1.33}{1.60}}$

l_{tmax} = 92.16

Regangan efektif,

ε_{fse} = $\min\left(\frac{\varepsilon_{df}}{2}\ ,\ 0.5\sqrt{\frac{f_{ctk}}{E_{fd}\ t_f}}\ ,\ 0.004\right)$

ε_{fse} = min (, 0.004 , 0.000)

maka di ambil ε_{fse} = 0.0020

Sehingga,

$V_{Rd,f} = \frac{A_{fw}}{s_f}\left(d_f\ \frac{n_s}{3}\ l_{tmax}\ \cos\beta\right) E_{fd}\ \varepsilon_{fse}\ \sin\beta + \cos\beta$ A_{fw} = 2 . 700 . 1.33

= 1862

$V_{Rd,f} = \frac{A_{fw}}{s_f}\left(d_f\ -\ \frac{n_s}{3}\ l_{tmax}\ \cos\ 90\right) E_{fd}\ \varepsilon_{fse}\ \left(\sin\ 90\ +\ \cos\ 90\right)$

$V_{Rd,f} = \frac{2240}{700}\ .\ \left(\ 262\ -\ \frac{1}{3}\ 92.16\ .\ 0.0\right)\ 20900\ .\ 0.002\ .\ \left(1.0\ +\ 0.0\right)$

= **35045.12** **N**

= **35.05** **kN**

Maka kuat geser total

V_n = V_c + V_s + V_f

= 30.09 + 25.33 + 35.05

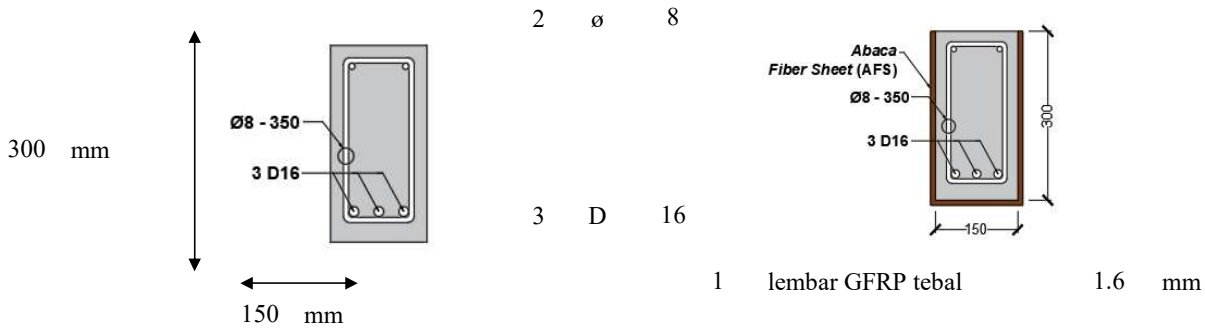
V_n = **90.46** **kN**

Analisis Teoritis Perkuatan Geser Balok EN 1998 TEORITIS DARI HASIL EKSPERIMENTAL

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif GFRP	d_f	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	d'	=	34	mm
Kuat tekan beton	f_{cm}	=	21.1	N/mm^2
Modulus elastisitas beton				
$E_c = 4700\ f'^{0.5}_c$				
$= 4700 \cdot 21.1^{0.5}$	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan FRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang NFRP



Data material NFRP

Ketebalan per lembaran	t_f	=	**1.60**	mm
Kuat tarik ultimit	f_{fbk}	=	**67.34**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.013**	mm/mm
Modulus elastisitas	E_f	=	**5009**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang
V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton
V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$$

$$= \frac{1}{6} \cdot 21.1^{0.5} \cdot 150 \cdot 262$$

V_c = 30087.25 N (30.09 kN)

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$$

$$= \frac{100.5 \cdot 336.8 \cdot 262}{350}$$

A_v = 100.480
= 100.480 mm^2

$V_{s\,eks}$ = 25331.40 N (25.33 kN)

Maka kuat geser nominal

$V_n = V_c + V_s$
= 30.09 + 25.33
V_n = 55.42 kN

Kuat geser akibat AFS

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi (V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$$V_n = 0.75 \; (Vc + Vs + 0.85) \; V_f$$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang

kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP,

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memberikan persamaan sebagai berikut

$$V_{FRP} = 0.9 \; d \; f_{fe} \; 2nt_f \; \cos\theta + \cot\beta \left(\frac{w_f}{s_f}\right)^2 \sin\beta$$

untuk U-wrap :

$$f_{fe} = f_{fd}\left\{1 - k\,\frac{L_e \sin\beta}{2z}\right\}$$

$$L_e = \sqrt{\frac{E_f \; n\,t_f}{4\;\tau_{max}}}$$

$$\tau_{max} = 1.80 \; f_{ctm} \; K_{EN} \quad , \quad f_{ctm} = 0.62\sqrt{21.10} = 2.85$$

$$K_{EN} = \left\{\sqrt{\frac{1.50\;(2 - w_f/s_f)}{1 + (w_f/100\;\text{mm})}}\right\}$$

$$K_{EN} = \left\{\frac{1.50\;(2 - 700/700)}{1 + (700/100\;\text{mm})}\right\}$$

$$= 0.188$$

$$\tau_{max} = 1.8 \;.\; 2.85 \;.\; 0.188$$

$$= 0.961$$

Sehingga,

$$L_e = \sqrt{\frac{5009 \;.\; 1 \;.\; 1.60}{4 \;.\; 0.96118}}$$

$$= 63.93 \;\; \text{N/mm}^2$$

$$f_{fe} = f_{fd}\left\{1 - k\,.\,\frac{L_e \,.\, \sin\beta}{2z}\right\}$$

$$f_{fd} = \frac{1}{\Upsilon_d}\sqrt{\frac{0.6 \; E_f \; f_{ctm}\; K_{EN}}{t_f}} \quad , \quad \Upsilon_d = 1.5$$

$$f_{fd} = \frac{1}{1.5}\sqrt{\frac{0.6 \;.\; 5009 \;.\; 2.85 \;.\; 0.188}{1 \;.\; 1.60}}$$

$$f_{fd} = 21.11 \;\; \text{N/mm}^2$$

$$k = 1 - \frac{2}{\pi} \quad , \quad z = 0{,}9.d = 235.8$$

Sehingga,

$$f_{fe} = f_{fd}\left\{1 - k\,\frac{L_e \,.\, \sin\beta}{z}\right\} \qquad 90$$

$$f_{fe} = 21.11 \,.\left\{1 - 0.363 \,.\, \frac{63.93 \,.\, 1}{235.8}\right\}$$

$$f_{fe} = 19.04 \quad \text{N/mm}^2$$

$$V_{FRP} = 0.9\; d\; f_{fe}\; 2nt_f \left(\cos\theta + \cot\beta\right) \frac{w_f}{s_f}^{2} \sin\beta$$

$$V_{FRP} = 0.9\; d\; f_{fe}\; 2nt_f \left(\cot 45 + \cot 90\right) \frac{w_f}{s_f}^{2} \sin 90$$

$$= 0.9 \,.\, 262.00 \,.\, 19.04 \,.\, 2.0 \,.\, 1 \,.\, 1.60 \left(1.00 + 0.00\right) \,.\, \frac{700}{700} \,.\, 1$$

$$= \mathbf{14363.89758}\ \mathbf{N}$$

$$= 14.36\ \mathbf{kN}$$

Maka kuat geser total

$$V_n = V_c + V_s + V_f$$

$$= 30.09 + 25.33 + 14.36$$

$$\boldsymbol{V_n} = \mathbf{69.78}\ \mathbf{kN}$$

Analisis Teoritis Perkuatan Geser Balok dengan GFRP

Data balok

Panjang balok	L	=	2.3	m
Tinggi balok	h	=	300	mm
Lebar Balok	b	=	150	mm
Lebar GFRP	w_f	=	700	mm
Tinggi efektif GFRP	d_f	=	262	mm
Jarak serat tekan ke titik berat tulangan tarik	d	=	262	mm
Jarak serat tekan ke titik berat tulangan tekan	d'	=	34	mm
Kuat tekan beton	f_{cm}	=	21.1	N/mm^2

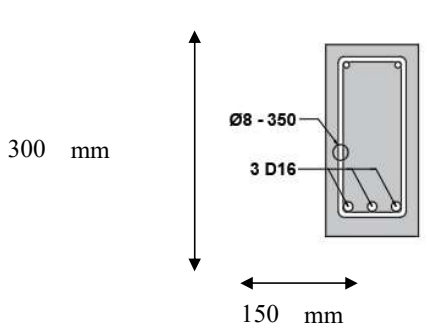
Modulus elastisitas beton

$E_c = 4700 \; f'^{0.5}_c$

$= 4700 \; . \; 21.1^{0.5}$

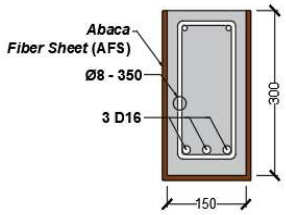
	E_c	=	21589	N/mm^2
Kuat leleh tulangan geser	f_y	=	336.78	N/mm^2
Jarak antar tulangan geser	s	=	350	mm
Faktor reduksi kuat lentur	Ø	=	**1**	
Faktor reduksi kekuatan FRP	ψ_f	=	**0.85**	
Tulangan Tekan (As')		=	100.48	mm^2
Tulangan Tarik (As)		=	602.88	mm^2

Gambar penampang benda uji sebelum dan setelah dipasang GFRP



2 ø 8

3 D 16



1 lembar GFRP tebal 1.33 mm

Data material NFRP

Ketebalan per lembaran	t_f	=	**1.33**	mm
Kuat tarik ultimit	f_{fbk}	=	**460.00**	N/mm^2
Regangan ultimit	ε^*_{fu}	=	**0.02**	mm/mm
Modulus elastisitas	E_f	=	**20900**	N/mm^2
Jumlah lapisan NFRP	n	=	**1**	
Sudut pemasangan NFRP		=	**90**	
Jarak pemasangan NFRP		=	**700**	mm

Data material tulangan geser

Kuat leleh tulangan	f_y	=	336.78	N/mm^2
Regangan leleh	ε_y	=	0.0016839	mm/mm
Modulus elastisitas	E_s	=	200000	N/mm^2

Properti material FRP untuk desain

Kondisi terekspos	Jenis FRP	Reduksi faktor lingkungan C_E
Interior	CFRP	0.95
	GFRP	0.75
Eksterior	CFRP	0.85
	GFRP	0.65
Lingkungan agresif yang mengandung zat kimia	CFRP	0.85
	GFRP	0.5

Syarat kuat geser

$V_u \leq \phi V_n$

Dimana : V_u = Gaya geser terfaktor pada penampang
V_n = Kuat geser nominal

$V_n = V_c + V_s$

Dimana : V_c = Kuat geser beton
V_s = Kuat geser tulangan sengkang

Kekuatan geser beton

$$V_c = \frac{1}{6} f_c'^{0.5} \; b \; d$$

$$= \frac{1}{6} \cdot 21.1^{0.5} \cdot 150 \cdot 262$$

V_c = 30087.25 N (30.09 kN)

Kekuatan geser Tulangan

$$V_{s\,eks} = \frac{A_v \; f_y \; d}{s}$$

$$= \frac{100.5 \cdot 336.8 \cdot 262}{350}$$

A_v = 100.480
= 100.480 mm^2

$V_{s\,eks}$ = 25331.40 N (25.33 kN)

Maka kuat geser nominal

$V_n = V_c + V_s$
= 30.09 + 25.33
V_n = 55.42 kN

Kuat geser akibat AFS

Berdasarkan persamaan yang diberikan ACI 440, kapasitas geser pada balok beton bertulang yang diperkuat dengan *FRP Composite dapat dihitung dengan persamaan :*

$$\Phi V_n = \Phi (V_c + V_s + \Psi V_f) \quad (1)$$

ACI 440 menjelaskan faktor reduksi untuk kapasitas geser pada balok beton bertulang dengan tiga sisi yang diberi perkuatan FRP sebagai berikut :

$$V_n = 0.75 \; (Vc + Vs + 0.85) \; V_f$$

terdapat dua kemungkinan kegagalan atau kehancuran yang terjadi pada perkuatan geser yang disumbang

kan FRP pada balok beton bertulang, yaitu kegagalan akibat retak atau patahnya FRP dan kegagalan akibat lepasnya rekatan FRP dengan balok beton bertulang.

Untuk perencanaan perkuatan geser berdasarkan kegagalan akibat retaknya (fracture mechanisme) FRP,

EN 1998-03 Eurocode 8 - Design of structures for earthquake resistance - Part 3: Assessment and retrofitting of buildings. Brussels: European Committee for Standardization; 2005

memberikan persamaan sebagai berikut

$$V_{FRP} = 0.9 \; d \; f_{fe} \; 2nt_f \; \cos\theta + \cot\beta \left(\frac{w_f}{s_f}\right)^2 \sin\beta$$

untuk U-wrap :

$$f_{fe} = f_{fd}\left\{1 - k\,\frac{L_e \sin\beta}{2z}\right\}$$

$$L_e = \sqrt{\frac{E_f \; n\,t_f}{\sqrt{4\;\tau_{max}}}}$$

$$\tau_{max} = 1.80 \; f_{ctm} \; K_{EN} \quad , \quad f_{ctm} = 0.62\sqrt{21.10} = 2.85$$

$$K_{EN} = \left\{\sqrt{\frac{1.50\,\left(2 - w_f/s_f\right)}{1 + \left(w_f/100\ \text{mm}\right)}}\right\}$$

$$K_{EN} = \left\{\frac{1.50\,\left(2 - 700/700\right)}{1 + \left(700/100\ \text{mm}\right)}\right\}$$

$$= 0.188$$

$$\tau_{max} = 1.8 \;.\; 2.85 \;.\; 0.188$$

$$= 0.961$$

Sehingga,

$$L_e = \sqrt{\frac{20900 \;.\; 1 \;.\; 1.33}{\sqrt{4 \;.\; 0.96118}}}$$

$$= 119.06 \ \text{N/mm}^2$$

$$f_{fe} = f_{fd}\left\{1 - k \;.\; \frac{L_e \;.\; \sin\beta}{2z}\right\}$$

$$f_{fd} = \frac{1}{\Upsilon_d}\sqrt{\frac{0.6 \; E_f \; f_{ctm}\, K_{EN}}{t_f}} \quad , \quad \Upsilon_d = 1.5$$

$$f_{fd} = \frac{1}{1.5}\sqrt{\frac{0.6 \;.\; 20900 \;.\; 2.85 \;.\; 0.188}{1 \;.\; 1.60}}$$

$$f_{fd} = 43.13 \ \text{N/mm}^2$$

$$k = 1 - \frac{2}{\pi} \quad , \quad z = 0{,}9.d = 235.8$$

Sehingga,

$$f_{fe} = f_{fd}\left\{1 - k\,\frac{L_e \,.\, \sin\beta \quad 90}{z}\right\}$$

$$f_{fe} = 43.13 \;.\left\{1 - 0.363 \;.\; \frac{119.06 \;.\; 1}{235.8}\right\}$$

$$f_{fe} = 35.22 \quad \text{N/mm}^2$$

$$V_{FRP} = 0.9 \;\; d \;\; f_{fe} \;\; 2nt_f \;\; \cos\theta + \cot\beta \;\; \left(\frac{w_f}{s_f}\right)^2 \;\; \sin\beta$$

$$V_{FRP} = 0.9 \;\; d \;\; f_{fe} \;\; 2nt_f \;\; \left(\cot 45 + \cot 90\right) \left(\frac{w_f}{s_f}\right)^2 \;\; \sin 90$$

$$= 0.9 \;.\; 262.00 \;.\; 35.22 \;.\; 2.0 \;.\; 1 \;.\; 1.60 \;\left(1.00 + 0.00\right) \;.\; \frac{700}{700} \;.\; 1$$

$$= \mathbf{26577.21369} \;\; \mathbf{N}$$

$$= 26.58 \quad \mathbf{kN}$$

Maka kuat geser total

$$V_n = V_c + V_s + V_f$$

$$= 30.09 + 25.33 + 26.58$$

$$\boldsymbol{V_n} = \mathbf{82.00} \;\; \mathbf{kN}$$