2 Blade Structural Properties

The NREL offshore 5-MW baseline wind turbine has three blades. We based the distributed blade structural properties of each blade on the structural properties of the 62.6-m-long LM Glasfiber blade used in the DOWEC study (using the data given in Appendix A of Ref. [17]). Because the blades in the DOWEC study were 1.1 m longer than the 61.5-m-long LM Glasfiber blades [18] used on the actual REpower 5M machine, we truncated the 62.6-m blades at 61.5-m span to obtain the structural properties of the NREL 5-MW baseline blades (we found the structural properties at the blade tip by interpolating between the 61.2-m and 61.7-m stations given in Appendix A of Ref. [17]). Table 2-1 lists the resulting properties.

The entries in the first column of Table 2-1, labeled "Radius," are the spanwise locations along the blade-pitch axis relative to the rotor center (apex). "BlFract" is the fractional distance along the blade-pitch axis from the root (0.0) to the tip (1.0). We located the blade root 1.5 m along the pitch axis from the rotor center, equivalent to half the hub diameter listed in Table 1-1.

"AeroCent" is the name of a FAST input parameter. The FAST code assumes that the blade-pitch axis passes through each airfoil section at 25% chord. By definition, then, the quantity (AeroCent − 0.25) is the fractional distance to the aerodynamic center from the blade-pitch axis along the chordline, positive toward the trailing edge. Thus, at the root (i.e., BlFract = 0.0), AeroCent = 0.25 means that the aerodynamic center lies on the blade-pitch axis [because (0.25 − 0.25) = 0.0], and at the tip (i.e., BlFract = 1.0), AeroCent = 0.125 means that the aerodynamic center lies 0.125 chordlengths toward the leading edge from the blade-pitch axis [because (0.125

Table 2-1. Distributed Blade Structural Properties

Radius (m)	BlFract (-)	AeroCent (-)	StrcTwst (°)	BMassDen (kg/m)	FlpStff (N•m²)	EdgStff (N•m²)	GJStff (N•m²)	EAStff (N)	Alpha (-)	FlpIner (kg•m)	EdgIner (kg•m)	PrecrvRef (m)	PreswpRef (m)	FlpcgOf (m)	EdgcgOf (m)	FlpEAOf (m)	EdgEAOf (m)
1.50	0.00000	0.25000	13.308	678.935	18110.00E+6	18113.60E+6	5564.40E+6	9729.48E+6	0.0	972.86	973.04	0.0	0.0	0.0	0.00017	0.0	0.0
1.70	0.00325	0.25000	13.308	678.935	18110.00E+6	18113.60E+6	5564.40E+6	9729.48E+6	0.0	972.86	973.04	0.0	0.0	0.0	0.00017	0.0	0.0
2.70	0.01951	0.24951	13.308	773.363	19424.90E+6	19558.60E+6	5431.59E+6	10789.50E+6	0.0	1091.52	1066.38	0.0	0.0	0.0	-0.02309	0.0	0.0
3.70	0.03577	0.24510	13.308	740.550	17455.90E+6	19497.80E+6	4993.98E+6	10067.23E+6	0.0	966.09	1047.36	0.0	0.0	0.0	0.00344	0.0	0.0
4.70	0.05203	0.23284	13.308	740.042	15287.40E+6	19788.80E+6	4666.59E+6	9867.78E+6	0.0	873.81	1099.75	0.0	0.0	0.0	0.04345	0.0	0.0
5.70	0.06829	0.22059	13.308	592.496	10782.40E+6	14858.50E+6	3474.71E+6	7607.86E+6	0.0	648.55	873.02	0.0	0.0	0.0	0.05893	0.0	0.0
6.70	0.08455	0.20833	13.308	450.275	7229.72E+6	10220.60E+6	2323.54E+6	5491.26E+6	0.0	456.76	641.49	0.0	0.0	0.0	0.06494	0.0	0.0
7.70	0.10081	0.19608	13.308	424.054	6309.54E+6	9144.70E+6	1907.87E+6	4971.30E+6	0.0	400.53	593.73	0.0	0.0	0.0	0.07718	0.0	0.0
8.70	0.11707	0.18382	13.308	400.638	5528.36E+6	8063.16E+6	1570.36E+6	4493.95E+6	0.0	351.61	547.18	0.0	0.0	0.0	0.08394	0.0	0.0
9.70	0.13335	0.17156	13.308	382.062	4980.06E+6	6884.44E+6	1158.26E+6	4034.80E+6	0.0	316.12	490.84	0.0	0.0	0.0	0.10174	0.0	0.0
10.70	0.14959	0.15931	13.308	399.655	4936.84E+6	7009.18E+6	1002.12E+6	4037.29E+6	0.0	303.60	503.86	0.0	0.0	0.0	0.10758	0.0	0.0
11.70	0.16585	0.14706	13.308	426.321	4691.66E+6	7167.68E+6	855.90E+6	4169.72E+6	0.0	289.24	544.70	0.0	0.0	0.0	0.15829	0.0	0.0
12.70	0.18211	0.13481	13.181	416.820	3949.46E+6	7271.66E+6	672.27E+6	4082.35E+6	0.0	246.57	569.90	0.0	0.0	0.0	0.22235	0.0	0.0
13.70	0.19837	0.12500	12.848	406.186	3386.52E+6	7081.70E+6	547.49E+6	4085.97E+6	0.0	215.91	601.28	0.0	0.0	0.0	0.30756	0.0	0.0
14.70	0.21465	0.12500	12.192	381.420	2933.74E+6	6244.53E+6	448.84E+6	3668.34E+6	0.0	187.11	546.56	0.0	0.0	0.0	0.30386	0.0	0.0
15.70	0.23089	0.12500	11.561	352.822	2568.96E+6	5048.96E+6	335.92E+6	3147.76E+6	0.0	160.84	468.71	0.0	0.0	0.0	0.26519	0.0	0.0
16.70	0.24715	0.12500	11.072	349.477	2388.65E+6	4948.49E+6	311.35E+6	3011.58E+6	0.0	148.56	453.76	0.0	0.0	0.0	0.25941	0.0	0.0
17.70	0.26341	0.12500	10.792	346.538	2271.99E+6	4808.02E+6	291.94E+6	2882.62E+6	0.0	140.30	436.22	0.0	0.0	0.0	0.25007	0.0	0.0
19.70	0.29595	0.12500	10.232	339.333	2050.05E+6	4501.40E+6	261.00E+6	2613.97E+6	0.0	124.61	398.18	0.0	0.0	0.0	0.23155	0.0	0.0
21.70	0.32846	0.12500	9.672	330.004	1828.25E+6	4244.07E+6	228.82E+6	2357.48E+6	0.0	109.42	362.08	0.0	0.0	0.0	0.20382	0.0	0.0
23.70	0.36098	0.12500	9.110	321.990	1588.71E+6	3995.28E+6	200.75E+6	2146.86E+6	0.0	94.36	335.01	0.0	0.0	0.0	0.19934	0.0	0.0
25.70	0.39350	0.12500	8.534	313.820	1361.93E+6	3750.76E+6	174.38E+6	1944.09E+6	0.0	80.24	308.57	0.0	0.0	0.0	0.19323	0.0	0.0
27.70	0.42602	0.12500	7.932	294.734	1102.38E+6	3447.14E+6	144.47E+6	1632.70E+6	0.0	62.67	263.87	0.0	0.0	0.0	0.14994	0.0	0.0
29.70	0.45855	0.12500	7.321	287.120	875.80E+6	3139.07E+6	119.98E+6	1432.40E+6	0.0	49.42	237.06	0.0	0.0	0.0	0.15421	0.0	0.0
31.70	0.49106	0.12500	6.711	263.343	681.30E+6	2734.24E+6	81.19E+6	1168.76E+6	0.0	37.34	196.41	0.0	0.0	0.0	0.13252	0.0	0.0
33.70	0.52358	0.12500	6.122	253.207	534.72E+6	2554.87E+6	69.09E+6	1047.43E+6	0.0	29.14	180.34	0.0	0.0	0.0	0.13313	0.0	0.0
35.70	0.55610	0.12500	5.546	241.666	408.90E+6	2334.03E+6	57.45E+6	922.95E+6	0.0	22.16	162.43	0.0	0.0	0.0	0.14035	0.0	0.0
37.70	0.58862	0.12500	4.971	220.638	314.54E+6	1828.73E+6	45.92E+6	760.82E+6	0.0	17.33	134.83	0.0	0.0	0.0	0.13950	0.0	0.0
39.70	0.62115	0.12500	4.401	200.293	238.63E+6	1584.10E+6	35.98E+6	648.03E+6	0.0	13.30	116.30	0.0	0.0	0.0	0.15134	0.0	0.0
41.70	0.65366	0.12500	3.834	179.404	175.88E+6	1323.36E+6	27.44E+6	539.70E+6	0.0	9.96	97.98	0.0	0.0	0.0	0.17418	0.0	0.0
43.70	0.68618	0.12500	3.332	165.094	126.01E+6	1183.68E+6	20.90E+6	531.15E+6	0.0	7.30	98.93	0.0	0.0	0.0	0.24922	0.0	0.0
45.70	0.71870	0.12500	2.890	154.411	107.26E+6	1020.16E+6	18.54E+6	460.01E+6	0.0	6.22	85.78	0.0	0.0	0.0	0.26022	0.0	0.0
47.70	0.75122	0.12500	2.503	138.935	90.88E+6	797.81E+6	16.28E+6	375.75E+6	0.0	5.19	69.96	0.0	0.0	0.0	0.22554	0.0	0.0
49.70	0.78376	0.12500	2.116	129.555	76.31E+6	709.61E+6	14.53E+6	328.89E+6	0.0	4.36	61.41	0.0	0.0	0.0	0.22795	0.0	0.0
51.70	0.81626	0.12500	1.730	107.264	61.05E+6	518.19E+6	9.07E+6	244.04E+6	0.0	3.36	45.44	0.0	0.0	0.0	0.20600	0.0	0.0
53.70	0.84878	0.12500	1.342	98.776	49.48E+6	454.87E+6	8.06E+6	211.60E+6	0.0	2.75	39.57	0.0	0.0	0.0	0.21662	0.0	0.0
55.70	0.88130	0.12500	0.954	90.248	39.36E+6	395.12E+6	7.08E+6	181.52E+6	0.0	2.21	34.09	0.0	0.0	0.0	0.22784	0.0	0.0
56.70	0.89756	0.12500	0.760	83.001	34.67E+6	353.72E+6	6.09E+6	160.25E+6	0.0	1.93	30.12	0.0	0.0	0.0	0.23124	0.0	0.0
57.70	0.91382	0.12500	0.574	72.906	30.41E+6	304.73E+6	5.75E+6	109.23E+6	0.0	1.69	20.15	0.0	0.0	0.0	0.14826	0.0	0.0
58.70	0.93008	0.12500	0.404	68.772	26.52E+6	281.42E+6	5.33E+6	100.08E+6	0.0	1.49	18.53	0.0	0.0	0.0	0.15346	0.0	0.0
59.20	0.93821	0.12500	0.319	66.264	23.84E+6	261.71E+6	4.94E+6	92.24E+6	0.0	1.34	17.11	0.0	0.0	0.0	0.15382	0.0	0.0
59.70	0.94636	0.12500	0.253	59.340	19.63E+6	158.81E+6	4.24E+6	63.23E+6	0.0	1.10	11.55	0.0	0.0	0.0	0.09470	0.0	0.0
60.20	0.95447	0.12500	0.216	55.914	16.00E+6	137.88E+6	3.66E+6	53.32E+6	0.0	0.89	9.77	0.0	0.0	0.0	0.09018	0.0	0.0
60.70	0.96260	0.12500	0.178	52.484	12.83E+6	118.79E+6	3.13E+6	44.53E+6	0.0	0.71	8.19	0.0	0.0	0.0	0.08561	0.0	0.0
61.20	0.97073	0.12500	0.140	49.114	10.08E+6	101.63E+6	2.64E+6	36.90E+6	0.0	0.56	6.82	0.0	0.0	0.0	0.08035	0.0	0.0
61.70	0.97886	0.12500	0.101	45.818	7.55E+6	85.07E+6	2.17E+6	29.92E+6	0.0	0.42	5.57	0.0	0.0	0.0	0.07096	0.0	0.0
62.20	0.98699	0.12500	0.062	41.669	4.60E+6	64.26E+6	1.58E+6	21.31E+6	0.0	0.25	4.01	0.0	0.0	0.0	0.05424	0.0	0.0
62.70	0.99512	0.12500	0.023	11.453	0.25E+6	6.61E+6	0.25E+6	4.85E+6	0.0	0.04	0.94	0.0	0.0	0.0	0.05387	0.0	0.0
63.00	1.00000	0.12500	0.000	10.319	0.17E+6	5.01E+6	0.19E+6	3.53E+6	0.0	0.02	0.68	0.0	0.0	0.0	0.05181	0.0	0.0