Appendix A

BASIC PROPERTIES OF MATERIALS

	E (GPa)	ν	ρ Kg/m^3	$\alpha \times 10^5$ $^\circ$ C^{-1}	Limit tensile stress MPa	ε failure %
Concrete	20-40	0.15	2400	2.0	4	
Carbon steel	207	0.30	7810	1.3	400-1600	1.8
Nickel stell	207	0.30	7750	1.3	400-1600	-
Stainless steel (18-8)	190	0.31	7750	1.6	400-1600	-
Alluminium (all alloys)	70	0.33	2710	2.2	140-600	-
Copper	110	0.33	8910	1.7	-	-
Cast iron gray	100	0.21	7200	1.1	-	-
Glass	46	0.25	2600	0.8	35-175	
Lead	37	0.43	11380	2.9	-	
Magnesium	45	0.35	1800	2.6	-	
Phosphor bronze	111	0.35	8170	1.8	-	
Wood (sense of fibers)	15	0.45	-	-	100	
Wood (transverse sense)	1	-	-	-	3.5	
Granit	60	0.27	-	-	4	
Diamant	1200	-	-	-		

Table A.1 CONVENTIONAL MATERIALS

	E MPa	ν
Unconsolidated sand	1034	0.3
Carbonates	2206	0.1
Shale	2413	0.1

Table A.2 SOILS

E. Oñate, *Structural Analysis with the Finite Element Method. Linear Statics: Volume 2: Beams, Plates and Shells*, Lecture Notes on Numerical Methods in Engineering and Sciences, DOI 10.1007/978-1-4020-8743-1,

	E (GPa)	ν	ρ Kg/m^3	$\alpha \times 10^{-5}$ $^\circ$ C^{-1}	Limit tensile stress MPa	ε failure %
E-Glass	72	0.25	2550	0.5	3400	4.5
S-Glass	86	0.20	2500	0.3	4600	1.5
Graphite	390	-	1900	-	2100	-
Boron (ϕ 0.1mm)	400	-	2600	0.4	3400	0.8
Aramid (Kplar 49)	130	-	1450	-	2700	-
Nylon	1.4	-	-	-	1000	-
Carbon	190	0.3 6 1410	0.05	1700	0.5	
Carbon HR (high resistance)	230	0.3	1750	0.02	3200	1.3
Carbon HM (high modulus)	390	0.35	1800	0.08	2500	0.6

Table A.3 FIBERS

	E (GPa)	ν	ρ Kg/m^3	$\alpha \times 10^{-5}$ $^\circ$ C^{-1}	Limit tensile stress MPa	ε failure %
Epoxy resin	4-5	0.4	1200	9-13	130	3-6
Phelonic resin	3	0.4	1300	9-13	40	3-6
Polyester resin	4	0.4	1200	2	50-100	2.5
Polypropylene	1.1-1-4	0.4	900	-	25	-
Polycarbonate	2.4	0.1	1200	-	60	-
Polystyrene	0.020	0.4	280	-	-	-
Rubber	0.002-0.007	0.5	-	-	-	-

Table A.4 RESINS AND POLYMERS

	E (GPa)	ν	Limit tensile stress MPa
Phoetal cranial bone	$E_1 = 3.8$ $E_2 = 1.0$	0.22	-
Adult cranial bone	4.46	0.22	
Fresh bone	2.1	0.25	110
Human cartilage	0.024	-	3
Human tendon	0.6	-	82

Table A.5 BIOLOGICAL MATERIALS

The mechanical properties of other materials can be found in [Co2,PP4].