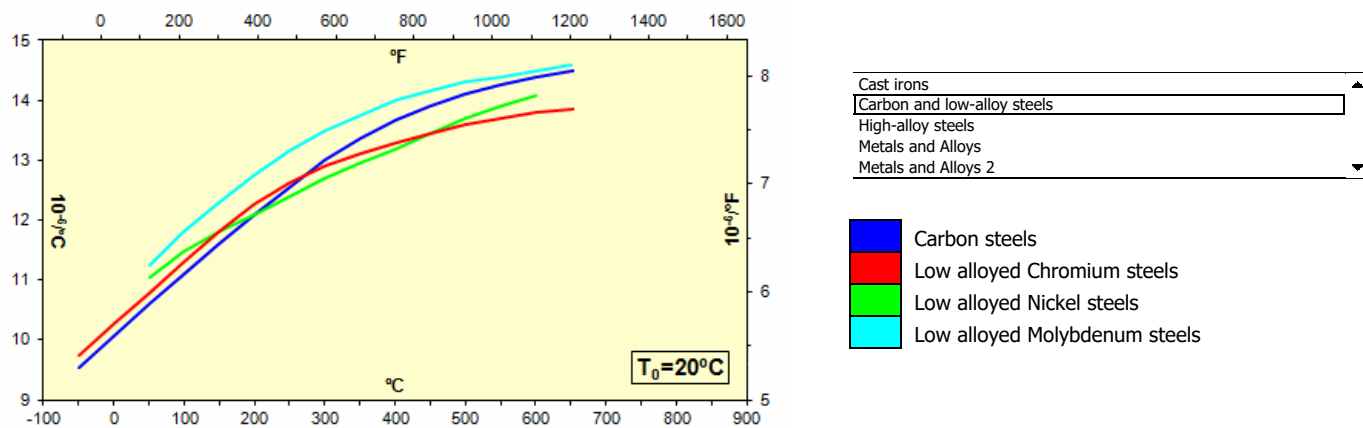




Influence of temperature on selected material parameters

A Linear coefficient of thermal expansion

1.0 Typical course of linear coefficient of thermal expansion



2.0 Calculation of linear coefficient of thermal expansion and component extension

2.1 Calculation units: Imperial (lbf, in, HP...)

2.2 Material

2.3 Material group: Medium Carbon steels [C ~ 0.25 - 0.6%]

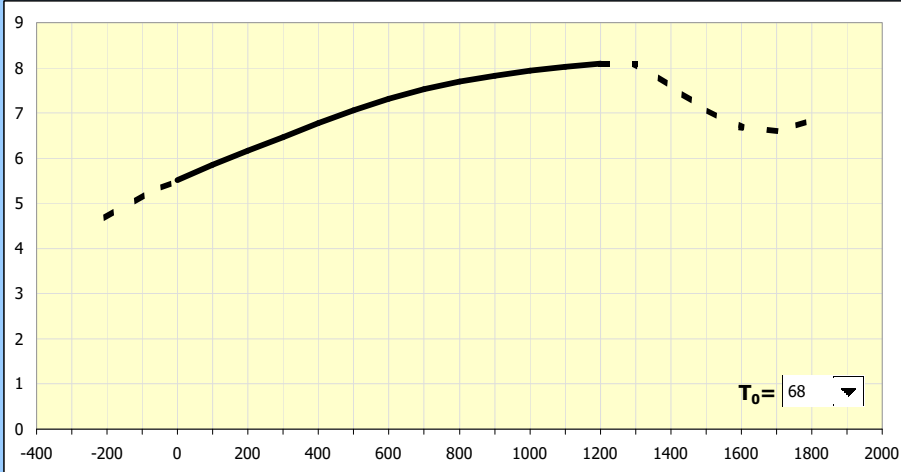
2.4 Typical values of thermal expansion coefficient: α_{20-100} = 5.5 - 7 [10⁻⁶/°F]

2.5 Known value of thermal expansion coefficient: α_{T_0-T} = 6.2 [10⁻⁶/°F]

2.6 for heating the material from the initial temperature: T_0 = 68 [°F]

2.7 to the end temperature: T = 212 [°F]

2.8 Linear coefficient of thermal expansion



2.9 Basic value of thermal expansion coefficient: α_{20-100} = 6.2 [10⁻⁶/°F]

2.10 Initial temperature: T_I = 68.0 [°F]

2.11 End temperature: T_E = 1000.0 [°F]

2.12 Searched value of thermal expansion coefficient: $\alpha_{T_I-T_E}$ = 7.9 [10⁻⁶/°F]

2.14 Component extension depending on temperature change

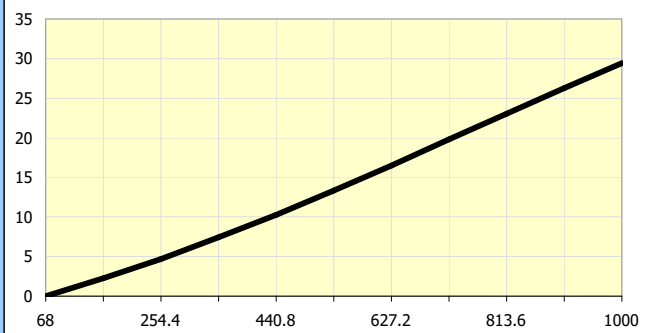
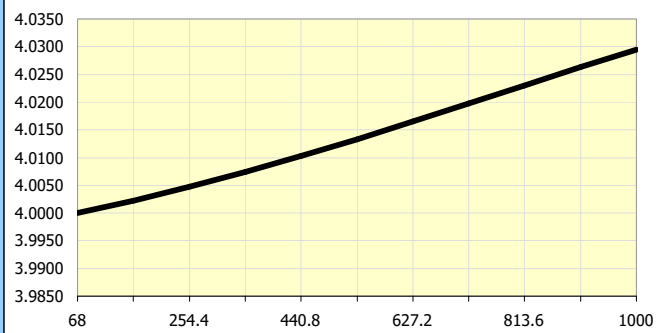
2.15 Initial length of components: L_0 = 4.00 [in]

2.16 End length of components: L = 4.0295 [in]

2.13 Indicative table of values

α	ΔT	Material
CAST IRONS		
Gray cast iron		
5.9	68-212	ASTM A48-25
5.9	68-212	ASTM A48-30
5.9	68-212	ASTM A48-35
5.9	68-212	ASTM A48-40
6.5	68-392	EN-GJL-150 [5.1200]
6.5	68-392	EN-GJL-200 [5.1300]
6.5	68-392	EN-GJL-250 [5.1301]
6.5	68-392	EN-GJL-300 [5.1302]
6.5	68-392	EN-GJL-350 [5.1303]
Ductile cast iron		
6.6	68-392	ASTM A536 60-40-18
6.8	68-392	ASTM A536 65-45-12
6.1	68-392	ASTM A536 80-55-06
6.1	68-392	ASTM A536 100-70-03
6.5	68-392	ASTM A536 120-90-02
6.6	68-392	EN-GJS-400-18 [5.3105]
6.8	68-392	EN-GJS-450-10 [5.3107]
6.5	68-392	EN-GJS-600-3 [5.3201]
6.5	68-392	EN-GJS-800-2 [5.3301]
Vermicular cast irons		
6.1	68-212	EN-GJV-300 [5.2100]
6.1	68-212	EN-GJV-350 [5.2200]
6.1	68-212	EN-GJV-400 [5.2201]
6.1	68-212	EN-GJV-450 [5.2300]
6.1	68-212	EN-GJV-500 [5.2301]
CARBON AND ALLOY STEELS		
7.0	32-212	AISI 1008 annealed
6.8	32-212	AISI 1010 annealed
6.6	32-212	AISI 1015 rolled
6.8	32-212	AISI 1015 annealed
6.7	32-212	AISI 1016 annealed

Component extension: ΔL = 29.5 [10⁻³ in]



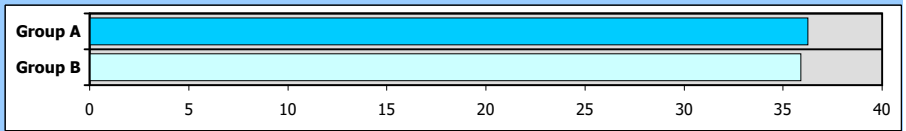
3.0 Extension of a group of components arranged in a linear chain

3.1 Initial temperature T_I [° F] End temperature T_{EA} [° F]
 3.2 Use different end temperature for components from the comparison group "B" T_{EB} [° F]

3.3 Definition of dimensional chain

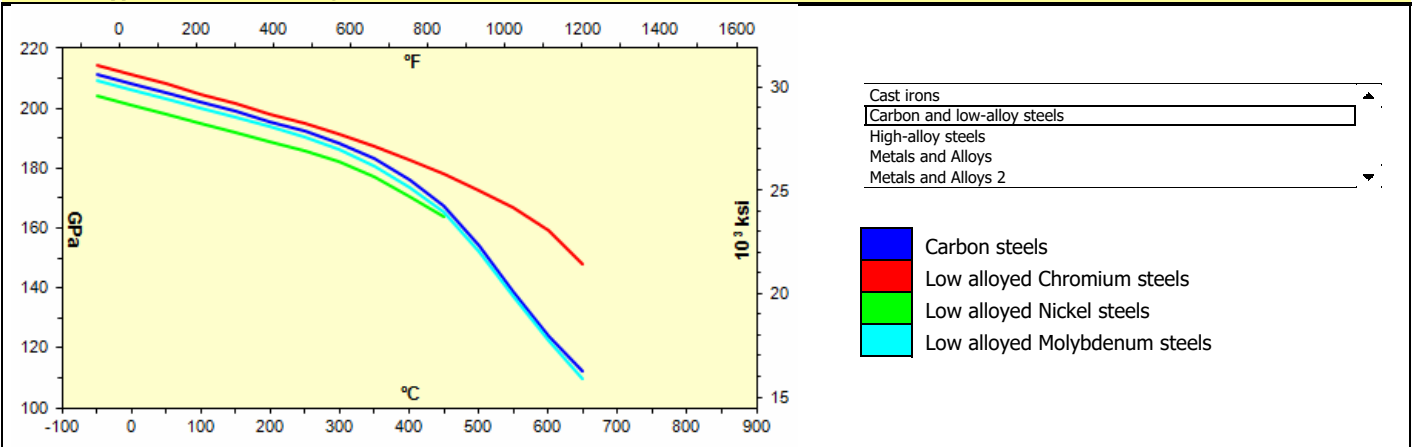
Group	Part	Initial length L [in]	Material group	Coefficient of thermal expansion		Component extension ΔL	
				α_{20-100}	$\alpha_{T_I-T_E}$	[10 ⁻³ in]	[%]
A	1	0.40	Nickel and Nickel alloys	7.2	7.7 <input checked="" type="checkbox"/>	1.3	3.67
A	2	0.30	Intermediate alloyed Chromium steels [Cr ~ 5 - 9%]	6.1	6.7 <input checked="" type="checkbox"/>	0.9	2.39
A	3	3.00	Austenitic stainless steels	8.9	9.3 <input checked="" type="checkbox"/>	12.1	33.22
A	4	6.80	Low Carbon steels [C ~ 0.05 - 0.3%]	6.7	7.5 <input checked="" type="checkbox"/>	22.0	60.72
B	5	6.50	Gray cast irons	6.0	6.8 <input checked="" type="checkbox"/>	19.1	53.25
B	6	4.00	Copper and Copper alloys	9.3	9.7 <input checked="" type="checkbox"/>	16.8	46.75
	7		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	8		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	9		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	10		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	11		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	12		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	13		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	14		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		
	15		Medium Carbon steels [C ~ 0.25 - 0.6%]		<input checked="" type="checkbox"/>		

3.4 Total extension [10⁻³ in]
 3.5 Group "A" ΔL_A
 3.6 Group "B" ΔL_B
 3.7 Groups difference "A-B" ΔL_{A-B}



B Young's modulus

4.0 Typical course of Young's modulus

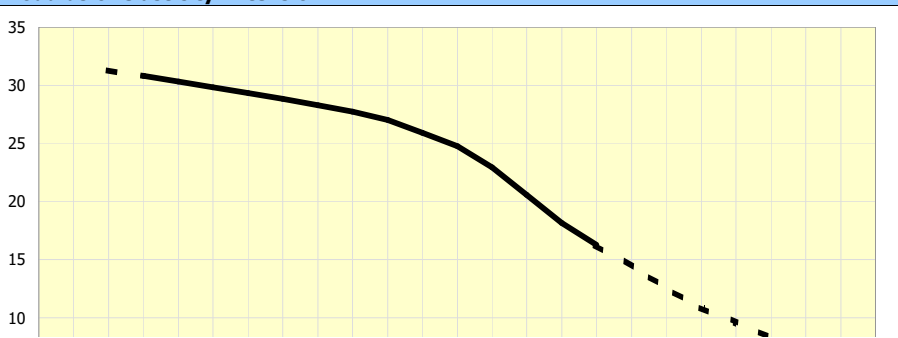


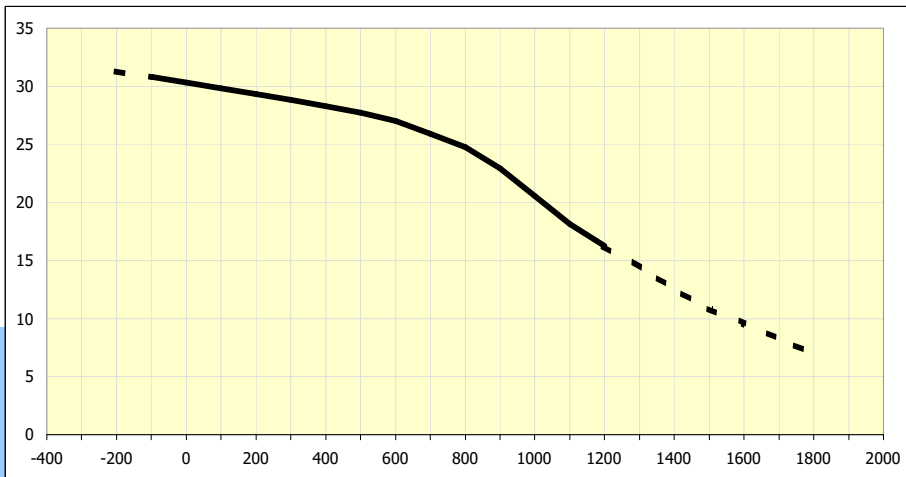
5.0 Calculation of modulus of elasticity

5.1 Calculation units
 5.2 Material
 5.3 Material group
 5.4 Typical values of Young's modulus E_{20} [10³ ksi]
 5.5 Known value of Young's modulus E_T [10³ ksi]
 5.6 for temperature T [° F]
 5.7 Modulus of elasticity in tension

5.14 Indicative table of values

E	T	Material
CAST IRONS		
Gray cast iron		
9.6-14.0	68	ASTM A48-20
11.5-14.8	68	ASTM A48-25
13.0-16.4	68	ASTM A48-30
14.5-17.2	68	ASTM A48-35
16.0-20.0	68	ASTM A48-40
18.8-22.8	68	ASTM A48-50
20.4-23.5	68	ASTM A48-60
11.3-14.9	68	EN-GJL-150 [5.1200]
12.8-16.4	68	EN-GJL-200 [5.1300]
14.9-17.1	68	EN-GJL-250 [5.1301]
15.7-19.9	68	EN-GJL-300 [5.1302]
17.8-20.7	68	EN-GJL-350 [5.1303]
Vermicular cast irons		
18.9-21.0	68	EN-GJV-300 [5.2100]
19.6-21.8	68	EN-GJV-350 [5.2200]
20.3-21.8	68	EN-GJV-400 [5.2201]
21.0-22.5	68	EN-GJV-450 [5.2300]
21.0-23.2	68	EN-GJV-500 [5.2301]





CAST IRONS			
Gray cast iron			
9.6-14.0	68		ASTM A48-20
11.5-14.8	68		ASTM A48-25
13.0-16.4	68		ASTM A48-30
14.5-17.2	68		ASTM A48-35
16.0-20.0	68		ASTM A48-40
18.8-22.8	68		ASTM A48-50
20.4-23.5	68		ASTM A48-60
11.3-14.9	68		EN-GJL-150 [5.1200]
12.8-16.4	68		EN-GJL-200 [5.1300]
14.9-17.1	68		EN-GJL-250 [5.1301]
15.7-19.9	68		EN-GJL-300 [5.1302]
17.8-20.7	68		EN-GJL-350 [5.1303]
Vermicular cast irons			
18.9-21.0	68		EN-GJV-300 [5.2100]
19.6-21.8	68		EN-GJV-350 [5.2200]
20.3-21.8	68		EN-GJV-400 [5.2201]
21.0-22.5	68		EN-GJV-450 [5.2300]
21.0-23.2	68		EN-GJV-500 [5.2301]
Tvárná litina			
23.8	68		ASTM A536 60-40-18
23.8	68		ASTM A536 65-45-12
25.2	68		ASTM A536 80-55-06
25.7	68		ASTM A536 100-70-03
25.7	68		ASTM A536 120-90-02
24.5	68		EN-GJS-350-22 [5.3102]
24.5	68		EN-GJS-400-18 [5.3105]
24.5	68		EN-GJS-450-10 [5.3107]
24.5	68		EN-GJS-500-7 [5.3200]
25.2	68		EN-GJS-600-3 [5.3201]
25.5	68		EN-GJS-700-2 [5.3300]
25.5	68		EN-GJS-800-2 [5.3301]
CARBON AND ALLOY STEELS			

5.8	Basic value of Young's modulus	E_{20}	30.0	[10 ³ ksi]
5.9	End temperature	T_E	1000	[° F]
5.10	Searched value of Young's modulus	E_{TE}	20.5	[10 ³ ksi]
5.11	Modulus of elasticity in shear			
5.12	Poisson's ratio	ν	0.30	[-]
5.13	Shear modulus	G_{TE}	7.9	[10 ³ ksi]