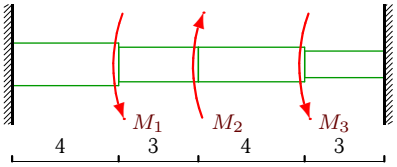
Кручение стержней кругового сечения

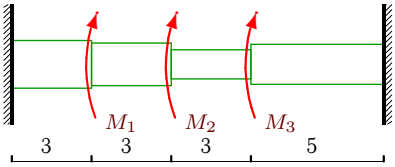
Найти моменты заделок опор стального стержня кусочно-постоянного круглого сечения. К стержню приложены моменты M_1, M_2, M_3. Построить эпюры углов закручивания. Модуль сдвига материала $G = 80$ГПа. Длины участков даны в м.

Задача 18.1.



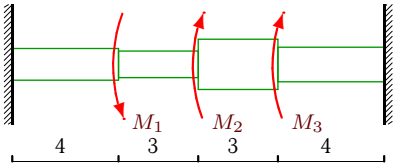
$M_1 = 12$кНм, $M_2 = 44$кНм, $M_3 = 10$кНм, $d_1 = 0.16$м, $d_2 = 0.13$м, $d_3 = 0.13$м, $d_4 = 0.1$м.

Задача 18.2.



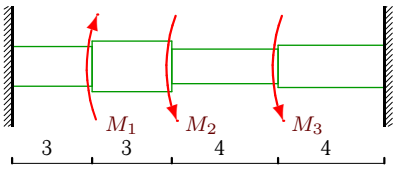
$M_1 = 24$кНм, $M_2 = 36$кНм, $M_3 = 6$кНм, $d_1 = 0.18$м, $d_2 = 0.16$м, $d_3 = 0.11$м, $d_4 = 0.15$м.

Задача 18.3.



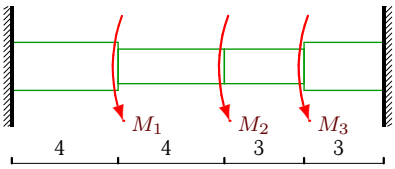
$M_1 = 9$кНм, $M_2 = 6$кНм, $M_3 = 52$кНм, $d_1 = 0.12$м, $d_2 = 0.1$м, $d_3 = 0.19$м, $d_4 = 0.13$м.

Задача 18.4.



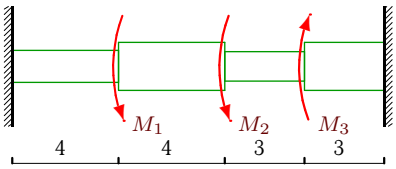
$M_1 = 10$кНм, $M_2 = 7$кНм, $M_3 = 24$кНм, $d_1 = 0.15$м, $d_2 = 0.19$м, $d_3 = 0.13$м, $d_4 = 0.16$м.

Задача 18.5.



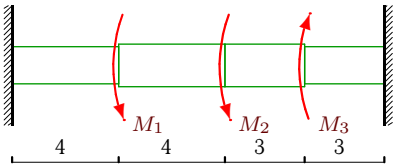
$M_1 = 24$кНм, $M_2 = 20$кНм, $M_3 = 7$кНм, $d_1 = 0.18$м, $d_2 = 0.13$м, $d_3 = 0.13$м, $d_4 = 0.18$м.

Задача 18.6.



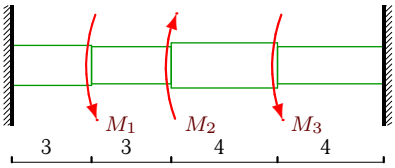
$M_1 = 56$кНм, $M_2 = 32$кНм, $M_3 = 16$кНм, $d_1 = 0.12$м, $d_2 = 0.18$м, $d_3 = 0.11$м, $d_4 = 0.18$м.

Задача 18.7.



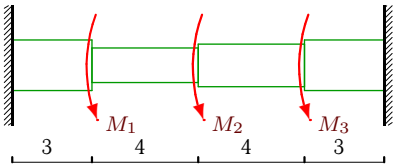
$M_1 = 48$кНм, $M_2 = 18$кНм, $M_3 = 6$кНм, $d_1 = 0.14$м, $d_2 = 0.16$м, $d_3 = 0.16$м, $d_4 = 0.14$м.

Задача 18.8.



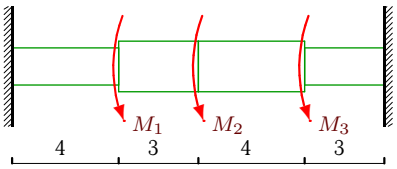
$M_1 = 7$кНм, $M_2 = 36$кНм, $M_3 = 12$кНм, $d_1 = 0.15$м, $d_2 = 0.14$м, $d_3 = 0.17$м, $d_4 = 0.14$м.

Задача 18.9.



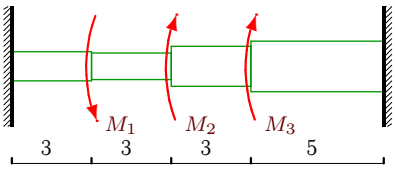
$M_1 = 7$кНм, $M_2 = 55$кНм, $M_3 = 9$кНм, $d_1 = 0.19$м, $d_2 = 0.13$м, $d_3 = 0.16$м, $d_4 = 0.19$м.

Задача 18.10.



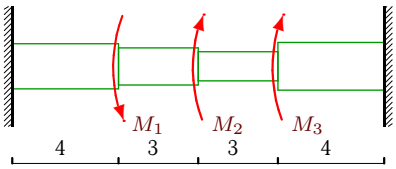
$M_1 = 50$кНм, $M_2 = 7$кНм, $M_3 = 24$кНм, $d_1 = 0.14$м, $d_2 = 0.19$м, $d_3 = 0.19$м, $d_4 = 0.14$м.

Задача 18.11.



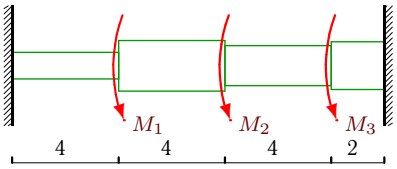
$M_1 = 7$кНм, $M_2 = 18$кНм, $M_3 = 44$кНм, $d_1 = 0.11$м, $d_2 = 0.1$м, $d_3 = 0.15$м, $d_4 = 0.19$м.

Задача 18.12.



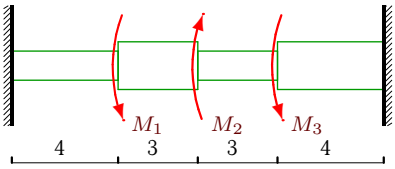
$M_1 = 35$кНм, $M_2 = 18$кНм, $M_3 = 52$кНм, $d_1 = 0.17$м, $d_2 = 0.14$м, $d_3 = 0.11$м, $d_4 = 0.18$м.

Задача 18.13.



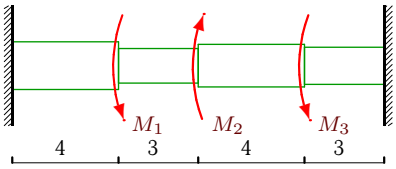
$M_1 = 44$кНм, $M_2 = 12$кНм, $M_3 = 28$кНм, $d_1 = 0.1$м, $d_2 = 0.19$м, $d_3 = 0.15$м, $d_4 = 0.18$м.

Задача 18.14.



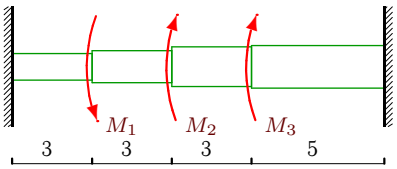
$M_1 = 28$кНм, $M_2 = 30$кНм, $M_3 = 7$кНм, $d_1 = 0.11$м, $d_2 = 0.18$м, $d_3 = 0.11$м, $d_4 = 0.18$м.

Задача 18.15.



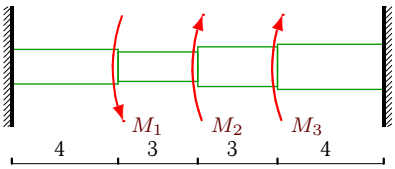
$M_1 = 36$кНм, $M_2 = 12$кНм, $M_3 = 24$кНм, $d_1 = 0.18$м, $d_2 = 0.13$м, $d_3 = 0.16$м, $d_4 = 0.14$м.

Задача 18.16.



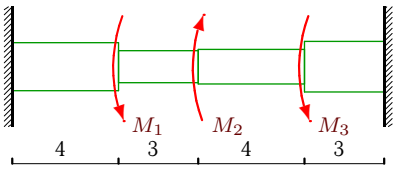
$M_1 = 7$кНм, $M_2 = 28$кНм, $M_3 = 33$кНм, $d_1 = 0.1$м, $d_2 = 0.12$м, $d_3 = 0.15$м, $d_4 = 0.16$м.

Задача 18.17.



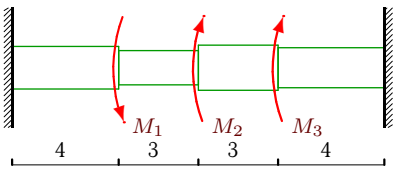
$M_1 = 14$кНм, $M_2 = 27$кНм, $M_3 = 12$кНм, $d_1 = 0.13$м, $d_2 = 0.11$м, $d_3 = 0.15$м, $d_4 = 0.17$м.

Задача 18.18.



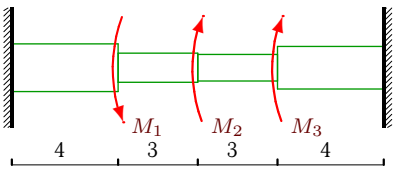
$M_1 = 27$кНм, $M_2 = 15$кНм, $M_3 = 65$кНм, $d_1 = 0.18$м, $d_2 = 0.12$м, $d_3 = 0.13$м, $d_4 = 0.19$м.

Задача 18.19.



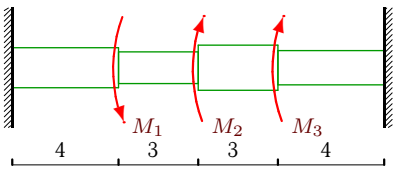
$M_1 = 30$кНм, $M_2 = 36$кНм, $M_3 = 9$кНм, $d_1 = 0.16$м, $d_2 = 0.13$м, $d_3 = 0.17$м, $d_4 = 0.15$м.

Задача 18.20.



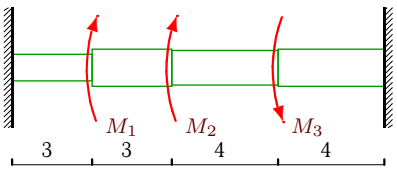
$M_1 = 8$кНм, $M_2 = 14$кНм, $M_3 = 27$кНм, $d_1 = 0.18$м, $d_2 = 0.11$м, $d_3 = 0.1$м, $d_4 = 0.16$м.

Задача 18.21.



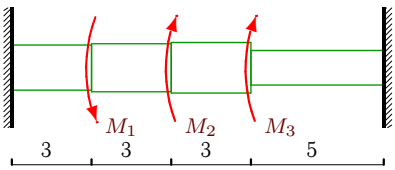
$M_1 = 16$кНм, $M_2 = 14$кНм, $M_3 = 36$кНм, $d_1 = 0.15$м, $d_2 = 0.12$м, $d_3 = 0.17$м, $d_4 = 0.13$м.

Задача 18.22.



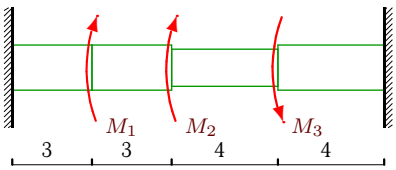
$M_1 = 8$кНм, $M_2 = 30$кНм, $M_3 = 55$кНм, $d_1 = 0.1$м, $d_2 = 0.14$м, $d_3 = 0.13$м, $d_4 = 0.14$м.

Задача 18.23.



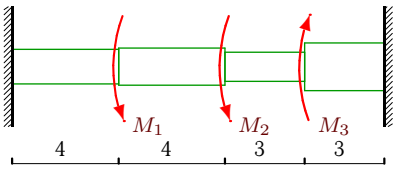
$M_1 = 7$кНм, $M_2 = 9$кНм, $M_3 = 10$кНм, $d_1 = 0.17$м, $d_2 = 0.18$м, $d_3 = 0.19$м, $d_4 = 0.13$м.

Задача 18.24.



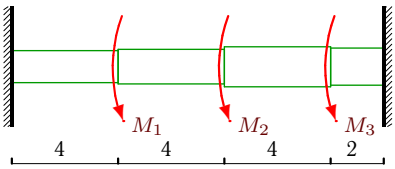
$M_1 = 6$кНм, $M_2 = 44$кНм, $M_3 = 7$кНм, $d_1 = 0.17$м, $d_2 = 0.17$м, $d_3 = 0.14$м, $d_4 = 0.17$м.

Задача 18.25.



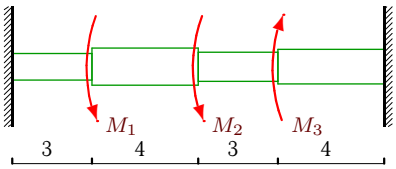
$M_1 = 39$кНм, $M_2 = 24$кНм, $M_3 = 20$кНм, $d_1 = 0.13$м, $d_2 = 0.14$м, $d_3 = 0.11$м, $d_4 = 0.18$м.

Задача 18.26.



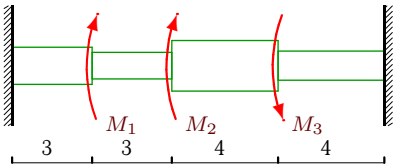
$M_1 = 60$кНм, $M_2 = 55$кНм, $M_3 = 7$кНм, $d_1 = 0.12$м, $d_2 = 0.13$м, $d_3 = 0.15$м, $d_4 = 0.14$м.

Задача 18.27.



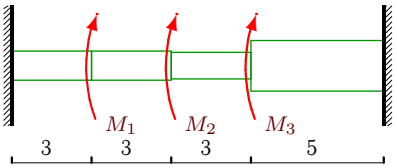
$M_1 = 7$кНм, $M_2 = 7$кНм, $M_3 = 30$кНм, $d_1 = 0.1$м, $d_2 = 0.14$м, $d_3 = 0.11$м, $d_4 = 0.13$м.

Задача 18.28.



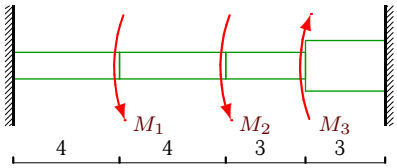
$M_1 = 6$кНм, $M_2 = 48$кНм,
$M_3 = 26$кНм, $d_1 = 0.14$м,
$d_2 = 0.1$м, $d_3 = 0.19$м,
$d_4 = 0.11$м.

Задача 18.29.



$M_1 = 18$кНм, $M_2 = 24$кНм,
$M_3 = 56$кНм, $d_1 = 0.11$м,
$d_2 = 0.11$м, $d_3 = 0.1$м,
$d_4 = 0.19$м.

Задача 18.30.



$M_1 = 65$кНм, $M_2 = 24$кНм,
$M_3 = 18$кНм, $d_1 = 0.1$м,
$d_2 = 0.1$м, $d_3 = 0.1$м,
$d_4 = 0.19$м.

18.1

Кручение стержней кругового сечения

№	M_A	φ_1	φ_2	φ_3
	кНм		рад·100	
1	-16.203	1.259	5.031	2.214
2	-52.672	1.917	3.588	1.676
3	-6.240	1.533	7.354	7.625
4	2.228	-0.168	-0.527	-1.459
5	30.280	-1.469	-2.589	-0.754
6	47.844	-11.751	-11.355	-0.879
7	36.801	-4.879	-4.009	-2.307
8	-9.028	0.681	2.275	1.057
9	25.893	-0.759	-4.128	-1.322
10	39.105	-5.184	-4.865	-4.166
11	-1.099	0.287	3.380	2.633
12	13.233	-0.807	1.357	2.340
13	13.949	-7.104	-5.930	-1.699
14	1.066	-0.371	0.609	-0.191
15	31.865	-1.546	-0.993	-1.604
16	-7.500	2.865	5.536	4.517
17	1.993	-0.355	2.777	1.646
18	21.279	-1.032	0.021	-1.633
19	6.229	-0.484	2.695	2.136
20	-3.601	0.175	3.201	2.285
21	-5.943	0.598	4.640	5.003
22	-6.712	2.564	2.436	-3.144
23	-7.414	0.339	0.864	1.022
24	-33.419	1.528	2.782	0.584
25	38.100	-6.794	-6.675	-0.178
26	51.379	-12.619	-11.082	-4.681
27	1.811	-0.692	-0.004	3.176
28	-16.286	1.619	5.548	4.075
29	-26.796	6.991	9.286	3.478
30	48.382	-24.641	-16.178	-0.663