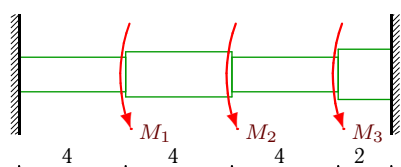


Кручение стержней кругового сечения

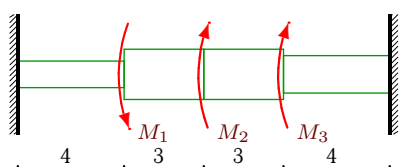
Найти моменты заделок опор стального стержня кусочно-постоянного круглого сечения. К стержню приложены моменты M_1 , M_2 , M_3 . Построить эпюры углов закручивания. Модуль сдвига материала $G = 80 \text{ ГПа}$. Длины участков даны в м.

Задача 18.1.



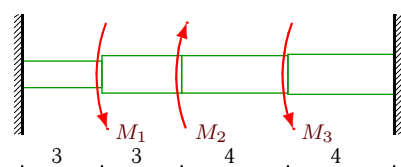
$$M_1 = 15 \text{ кНм}, M_2 = 55 \text{ кНм}, \\ M_3 = 8 \text{ кНм}, d_1 = 0.13 \text{ м}, \\ d_2 = 0.17 \text{ м}, d_3 = 0.13 \text{ м}, \\ d_4 = 0.19 \text{ м}.$$

Задача 18.2.



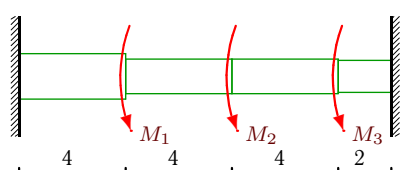
$$M_1 = 30 \text{ кНм}, M_2 = 32 \text{ кНм}, \\ M_3 = 12 \text{ кНм}, d_1 = 0.1 \text{ м}, \\ d_2 = 0.19 \text{ м}, d_3 = 0.19 \text{ м}, \\ d_4 = 0.14 \text{ м}.$$

Задача 18.3.



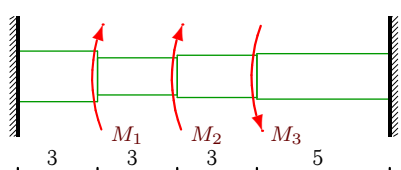
$$M_1 = 7 \text{ кНм}, M_2 = 36 \text{ кНм}, \\ M_3 = 26 \text{ кНм}, d_1 = 0.1 \text{ м}, \\ d_2 = 0.14 \text{ м}, d_3 = 0.14 \text{ м}, \\ d_4 = 0.15 \text{ м}.$$

Задача 18.4.



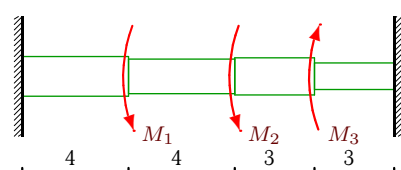
$$M_1 = 12 \text{ кНм}, M_2 = 30 \text{ кНм}, \\ M_3 = 55 \text{ кНм}, d_1 = 0.17 \text{ м}, \\ d_2 = 0.13 \text{ м}, d_3 = 0.13 \text{ м}, \\ d_4 = 0.12 \text{ м}.$$

Задача 18.5.



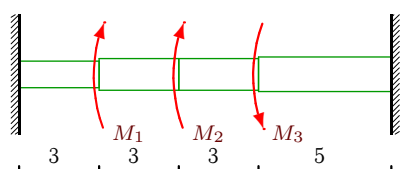
$$M_1 = 16 \text{ кНм}, M_2 = 20 \text{ кНм}, \\ M_3 = 7 \text{ кНм}, d_1 = 0.19 \text{ м}, \\ d_2 = 0.14 \text{ м}, d_3 = 0.16 \text{ м}, \\ d_4 = 0.17 \text{ м}.$$

Задача 18.6.



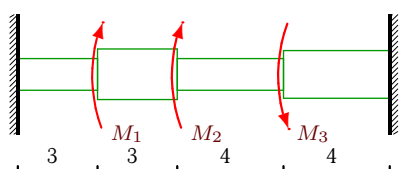
$$M_1 = 33 \text{ кНм}, M_2 = 9 \text{ кНм}, \\ M_3 = 11 \text{ кНм}, d_1 = 0.15 \text{ м}, \\ d_2 = 0.13 \text{ м}, d_3 = 0.14 \text{ м}, \\ d_4 = 0.1 \text{ м}.$$

Задача 18.7.



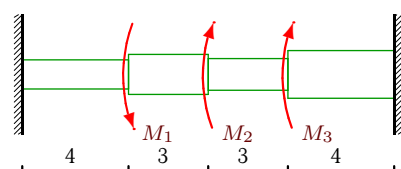
$$M_1 = 28 \text{ кНм}, M_2 = 30 \text{ кНм}, \\ M_3 = 7 \text{ кНм}, d_1 = 0.1 \text{ м}, \\ d_2 = 0.12 \text{ м}, d_3 = 0.12 \text{ м}, \\ d_4 = 0.13 \text{ м}.$$

Задача 18.8.



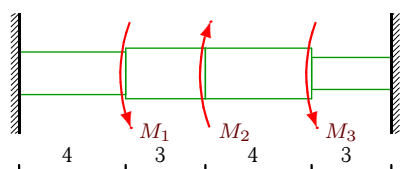
$$M_1 = 9 \text{ кНм}, M_2 = 13 \text{ кНм}, \\ M_3 = 39 \text{ кНм}, d_1 = 0.12 \text{ м}, \\ d_2 = 0.19 \text{ м}, d_3 = 0.12 \text{ м}, \\ d_4 = 0.18 \text{ м}.$$

Задача 18.9.



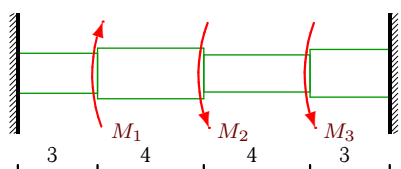
$$M_1 = 32 \text{ кНм}, M_2 = 18 \text{ кНм}, \\ M_3 = 11 \text{ кНм}, d_1 = 0.11 \text{ м}, \\ d_2 = 0.15 \text{ м}, d_3 = 0.12 \text{ м}, \\ d_4 = 0.18 \text{ м}.$$

Задача 18.10.



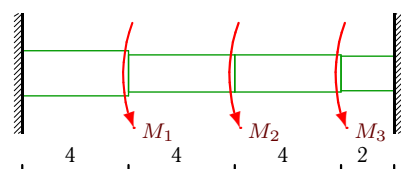
$$M_1 = 28 \text{ кНм}, M_2 = 45 \text{ кНм}, \\ M_3 = 40 \text{ кНм}, d_1 = 0.16 \text{ м}, \\ d_2 = 0.19 \text{ м}, d_3 = 0.19 \text{ м}, \\ d_4 = 0.12 \text{ м}.$$

Задача 18.11.



$$M_1 = 30 \text{ кНм}, M_2 = 60 \text{ кНм}, \\ M_3 = 16 \text{ кНм}, d_1 = 0.15 \text{ м}, \\ d_2 = 0.19 \text{ м}, d_3 = 0.14 \text{ м}, \\ d_4 = 0.18 \text{ м}.$$

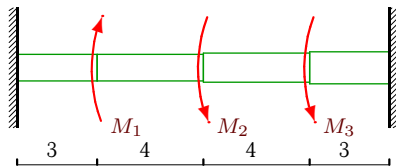
Задача 18.12.



$$M_1 = 56 \text{ кНм}, M_2 = 60 \text{ кНм}, \\ M_3 = 35 \text{ кНм}, d_1 = 0.17 \text{ м}, \\ d_2 = 0.14 \text{ м}, d_3 = 0.14 \text{ м}, \\ d_4 = 0.13 \text{ м}.$$

Задача 18.13.

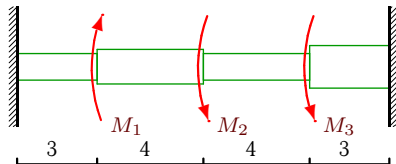
3



$M_1 = 15\text{кНм}$, $M_2 = 55\text{кНм}$,
 $M_3 = 7\text{кНм}$, $d_1 = 0.1\text{м}$,
 $d_2 = 0.1\text{м}$, $d_3 = 0.11\text{м}$,
 $d_4 = 0.12\text{м}$.

Задача 18.16.

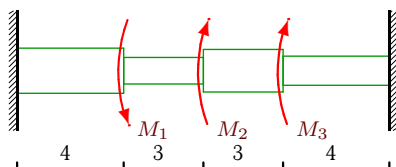
3



$M_1 = 39\text{кНм}$, $M_2 = 36\text{кНм}$,
 $M_3 = 20\text{кНм}$, $d_1 = 0.1\text{м}$,
 $d_2 = 0.13\text{м}$, $d_3 = 0.1\text{м}$,
 $d_4 = 0.16\text{м}$.

Задача 18.19.

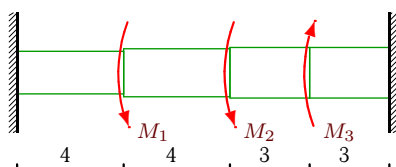
3



$M_1 = 14\text{кНм}$, $M_2 = 18\text{кНм}$,
 $M_3 = 36\text{кНм}$, $d_1 = 0.17\text{м}$,
 $d_2 = 0.1\text{м}$, $d_3 = 0.16\text{м}$,
 $d_4 = 0.11\text{м}$.

Задача 18.22.

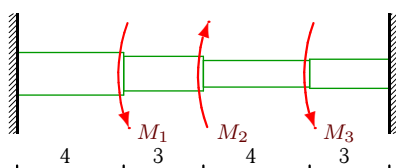
3



$M_1 = 65\text{кНм}$, $M_2 = 27\text{кНм}$,
 $M_3 = 6\text{кНм}$, $d_1 = 0.16\text{м}$,
 $d_2 = 0.18\text{м}$, $d_3 = 0.19\text{м}$,
 $d_4 = 0.19\text{м}$.

Задача 18.25.

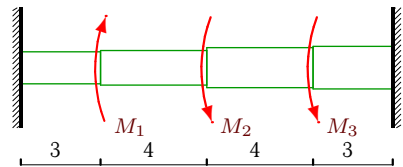
3



$M_1 = 28\text{кНм}$, $M_2 = 33\text{кНм}$,
 $M_3 = 10\text{кНм}$, $d_1 = 0.16\text{м}$,
 $d_2 = 0.13\text{м}$, $d_3 = 0.1\text{м}$,
 $d_4 = 0.11\text{м}$.

Задача 18.14.

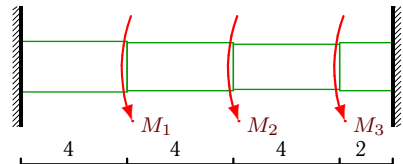
3



$M_1 = 30\text{кНм}$, $M_2 = 55\text{кНм}$,
 $M_3 = 12\text{кНм}$, $d_1 = 0.12\text{м}$,
 $d_2 = 0.13\text{м}$, $d_3 = 0.15\text{м}$,
 $d_4 = 0.16\text{м}$.

Задача 18.17.

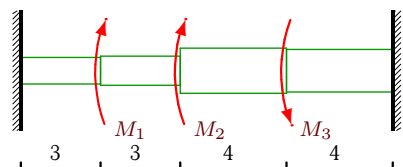
3



$M_1 = 28\text{кНм}$, $M_2 = 44\text{кНм}$,
 $M_3 = 12\text{кНм}$, $d_1 = 0.19\text{м}$,
 $d_2 = 0.18\text{м}$, $d_3 = 0.17\text{м}$,
 $d_4 = 0.18\text{м}$.

Задача 18.20.

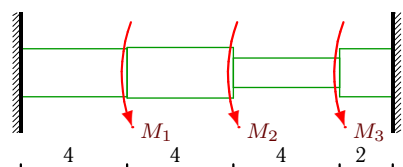
3



$M_1 = 24\text{кНм}$, $M_2 = 30\text{кНм}$,
 $M_3 = 45\text{кНм}$, $d_1 = 0.1\text{м}$,
 $d_2 = 0.11\text{м}$, $d_3 = 0.17\text{м}$,
 $d_4 = 0.16\text{м}$.

Задача 18.23.

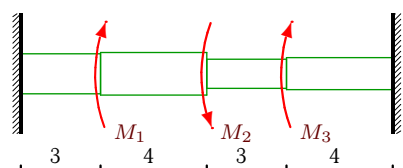
3



$M_1 = 75\text{кНм}$, $M_2 = 65\text{кНм}$,
 $M_3 = 27\text{кНм}$, $d_1 = 0.18\text{м}$,
 $d_2 = 0.19\text{м}$, $d_3 = 0.11\text{м}$,
 $d_4 = 0.18\text{м}$.

Задача 18.26.

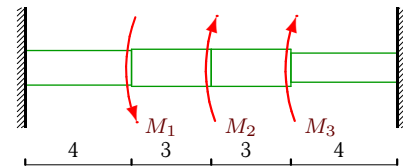
3



$M_1 = 39\text{кНм}$, $M_2 = 18\text{кНм}$,
 $M_3 = 44\text{кНм}$, $d_1 = 0.15\text{м}$,
 $d_2 = 0.16\text{м}$, $d_3 = 0.11\text{м}$,
 $d_4 = 0.12\text{м}$.

Задача 18.15.

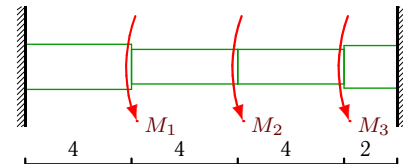
3



$M_1 = 12\text{кНм}$, $M_2 = 36\text{кНм}$,
 $M_3 = 13\text{кНм}$, $d_1 = 0.13\text{м}$,
 $d_2 = 0.14\text{м}$, $d_3 = 0.14\text{м}$,
 $d_4 = 0.11\text{м}$.

Задача 18.18.

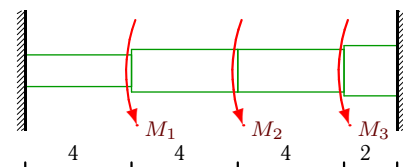
3



$M_1 = 56\text{кНм}$, $M_2 = 44\text{кНм}$,
 $M_3 = 9\text{кНм}$, $d_1 = 0.17\text{м}$,
 $d_2 = 0.13\text{м}$, $d_3 = 0.13\text{м}$,
 $d_4 = 0.16\text{м}$.

Задача 18.21.

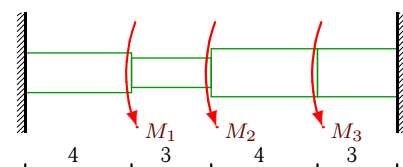
3



$M_1 = 30\text{кНм}$, $M_2 = 55\text{кНм}$,
 $M_3 = 14\text{кНм}$, $d_1 = 0.12\text{м}$,
 $d_2 = 0.16\text{м}$, $d_3 = 0.16\text{м}$,
 $d_4 = 0.19\text{м}$.

Задача 18.24.

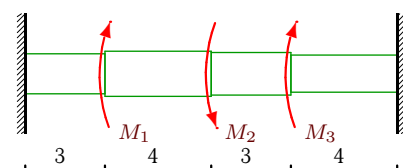
3



$M_1 = 40\text{кНм}$, $M_2 = 7\text{кНм}$,
 $M_3 = 18\text{кНм}$, $d_1 = 0.15\text{м}$,
 $d_2 = 0.11\text{м}$, $d_3 = 0.18\text{м}$,
 $d_4 = 0.18\text{м}$.

Задача 18.27.

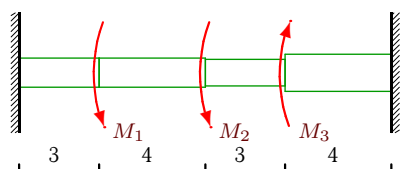
3



$M_1 = 24\text{кНм}$, $M_2 = 14\text{кНм}$,
 $M_3 = 39\text{кНм}$, $d_1 = 0.15\text{м}$,
 $d_2 = 0.17\text{м}$, $d_3 = 0.16\text{м}$,
 $d_4 = 0.14\text{м}$.

Задача 18.28.

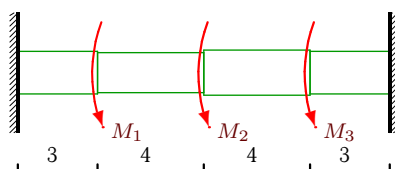
3



$$M_1 = 7 \text{кНм}, M_2 = 35 \text{кНм},$$
$$M_3 = 24 \text{кНм}, d_1 = 0.11 \text{м},$$
$$d_2 = 0.11 \text{м}, d_3 = 0.1 \text{м},$$
$$d_4 = 0.14 \text{м}.$$

Задача 18.29.

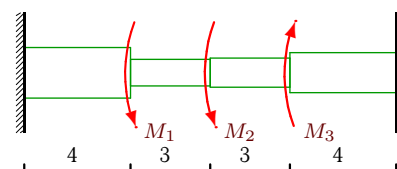
3



$$M_1 = 7 \text{кНм}, M_2 = 11 \text{кНм},$$
$$M_3 = 11 \text{кНм}, d_1 = 0.16 \text{м},$$
$$d_2 = 0.15 \text{м}, d_3 = 0.17 \text{м},$$
$$d_4 = 0.16 \text{м}.$$

Задача 18.30.

3



$$M_1 = 20 \text{кНм}, M_2 = 7 \text{кНм},$$
$$M_3 = 26 \text{кНм}, d_1 = 0.19 \text{м},$$
$$d_2 = 0.1 \text{м}, d_3 = 0.11 \text{м},$$
$$d_4 = 0.15 \text{м}.$$

Кручение стержней кругового сечения

№	M_A	φ_1	φ_2	φ_3
	кНм	рад·100		
1	34.132	-6.086	-7.253	-0.857
2	-1.478	0.753	1.675	1.660
3	-4.829	1.844	3.021	-0.184
4	39.860	-2.431	-7.399	-7.017
5	-22.411	0.657	1.294	0.502
6	28.806	-2.898	-2.150	-0.838
7	-27.956	10.679	10.671	5.136
8	-9.539	1.757	1.773	-1.288
9	7.833	-2.725	-0.901	0.234
10	13.300	-1.034	-0.603	-1.787
11	15.798	-1.192	-2.982	-1.099
12	87.327	-5.325	-9.478	-5.677
13	10.491	-4.007	-16.990	-6.725
14	-1.300	0.240	-4.878	-2.232
15	-19.397	3.459	6.581	6.123
16	-6.642	2.537	-3.233	-1.378
17	45.053	-1.761	-2.588	-0.945
18	70.219	-4.282	-6.817	-1.507
19	-10.364	0.632	9.938	10.309
20	-13.120	5.011	2.173	-0.320
21	25.849	-6.349	-6.026	-1.429
22	45.284	-3.519	-2.563	-1.193
23	121.124	-5.876	-7.679	-1.113
24	33.784	-3.399	-1.777	-1.136
25	2.549	-0.198	3.206	-0.639
26	-37.101	2.799	2.652	6.852
27	-26.101	1.969	2.097	3.036
28	18.574	-4.846	-8.872	0.076
29	12.555	-0.732	-1.291	-0.959
30	18.892	-0.738	-0.315	1.800