FEDERATION EUROPEENNE DE LA MANUTENTION
Section IX
Series Lifting Equipment

Chain qualities, selection criteria and requirements

FEM 9.671
1st edition (E)
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1 Scope

Dimensioning of round-steel load chains for series lifting equipment in manual and motorised operation.

1.1 Operating conditions

The chain lifting equipment should be classed in groups of mechanisms according to the prevailing operating conditions, taking into account the load spectrum and operating time as per FEM 9.511, and coordinated between manufacturer and user.

1.1.1 Normal classification

The influencing factors for normal classification in the FEM groups

1 Dm: Manual operation
1 Bm: Normal operation } For motorised lifting
2 m: Heavy operation } equipment

can be taken directly from Tables 2, 3 and 11.

1.1.2 Special classification

If the chain lifting equipment is to be classed in other FEM groups, the chain force F used in the following equations must be multiplied by the correction factor indicated in Table 1. Note that the values for the 1 Bm group of mechanisms from Tables 3 and 11 are to be used in the equation in these cases.

Table 1. **Correction factor**

FEM group (ISO)	1 Dm (M 1)	1 Cm (M 2)	1 Bm (M 3)	1 Am (M 4)	2 m (M 5)	3 m (M 6)	4 m (M 7)	5 m (M 8)
Correction factor	0,8	0,9	1	1,12	1,25	1,4	1,6	1,8

2 Round-steel chains

2.1 Chain quality

Only calibrated round-steel chains may be used for series lifting equipment.

2.1.1 Quality classes

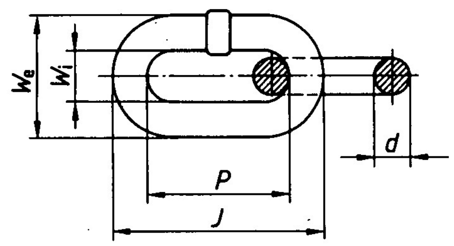
The round-steel chains are devided into quality classes as per Table 2 according to their breaking strength and surface hardness.

Table 2. **Quality classes**

Characteristics			Quality class FEM					
			P (5)	S (6)	T (8)	DS (6 S)	DT (8 S)	DAT (8 SS)
Load stress during reception test		N/mm²	250	315	400	315	400	400
min. breaking stress σ_B min.		N/mm²	500	630	800	630	800	800
min. elongation at break *)		%	10	10	10	5	5	10
min. surface hardness $d \leqslant 6{,}5$ mm HV 5			330	330	360	500	500	500
min. surface hardness $d = 7 - 11$ mm HV 10			330	330	360	500	500	500
min. surface hardness $d > 11$ mm HV 10			300	330	360	400	–	450
Permissible limit stress $\sigma_{Lim.}$ N/mm²	1 Dm	(M 1)	160	200	250	200	250	250
	1 Bm	(M 3)	125	160	200	160	200	200
	2 m	(M 5)	100	125	160	125	160	160

*) Sample length, 5 links
Total elongation at break according to stress/strain diagram

2.2 Dimensions



Nominal diameter: d
Inner length or pitch: $P \approx 3 \cdot d$
Outer length: $J = P + 2 \cdot d$
Inner width: $W_i \approx 1{,}3 \cdot d$
Outer width: $W_e \approx 3{,}3 \cdot d$

2.3 Design of chain

The minimum diameter of the chain depends on the following influencing variables:

- Operating conditions
- Quality class of the chain
- Numbers of recesses of the driven chain wheel
- Chain speed
- Chain size (pitch)
- Impact factor
- Factor for alternating stress amplitude according to quality class
- Polygonal geometry of the driven recess wheel

2.3.1 Diameter of the chain under dynamic stresses

2.3.1.1 Diameter d_1 resulting from load and chain running conditions

$$d_1 \geq c_1 \sqrt{(1 + 0{,}015 \cdot \frac{c_3 \cdot c_4}{c_2}) \cdot c_7 \cdot F}$$

Note: $(1 + 0{,}015 \cdot \frac{c_3 \cdot c_4}{c_2}) \cdot c_7 \geq c_6$

where

- d_1 Diameter in mm
- F Chain force in N resulting from the load-bearing capacity
- c_1 Factor for quality class and group of mechanisms
- c_2 Factor for numer of recesses of the driven chain wheels
- c_3 Factor for chain speed
- c_4 Factor for chain diameter (pitch)
- c_6 Factor for alternating stress amplitude according to quality class
- c_7 Magnification factor resulting from polygonal geometry of the driven recess wheel

The tables contain rounded values; the exact values can also be calculated.

Table 3. **Factor c_1** $\quad c_1 = \sqrt{\frac{2}{\sigma_{Lim.} \cdot \pi}}$

Group of mechanisms		Quality class FEM		
		P (5)	S (6) DS (6 S)	DAT (8 SS) DT (8 S) T (8)
1 Dm (M1)	Manual operation	0,063	0,056	0,05
1 Bm (M3)	Mot. normal operation	0,071	0,063	0,056
2 m (M5)	Mot. heavy operation	0,08	0,071	0,063

Table 4. **Factor c_2** $\quad c_2 = \frac{z^2}{10}$

No. of recesses z	3	4	5	6	7	8	9	≥10
Factor c_2 ≈	1	1,5	2,5	3,5	5	6,5	8	10

Table 5. **Factor c_3** $\quad c_3 = (\frac{V}{60})^2 \cdot 100$

Chain speed V up to ... m/min	6	8	10	12,5	16	20	25	31,5	40	50	63
Factor c_3 ≈	1	2	3	4	7	11	17	28	44	70	110

Table 6. **Factor c_4** $\quad c_4 = \frac{\pi^2 \cdot 100}{4{,}5 \cdot d \cdot g} \quad g = 9{,}81\ m/s^2 \quad$ c_4 should be determined by iteration

d in mm	4	5	6	6,5	7	8	9	10	11	11,5	13	14	16	18	20	22
Factor c_4 ≈	5,6	4,5	3,7	3,4	3,2	2,8	2,5	2,2	2	1,9	1,7	1,6	1,4	1,2	1,1	1

Table 7. **Factor c_6** $\quad c_6 = \frac{\sigma_{Lim.} \cdot z_{p\ mini\ stat}}{\sigma_B} \quad z_{p\ mini\ stat}$ = Minimum static safety against fracture (see Tables 2 and 11)

Quality class of the chain; FEM	c_6
P, S, T, DAT	1,25
DT, DS	2