



# Rules for the Design of Serial Lifting Equipment

## Classification of Mechanisms

# FEM

# 9.511

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### 1 Scope

These design rules apply to the classification of mechanisms for serial hoists and cranes equipped with serial hoists.

### 2 Classification of mechanisms according to operating conditions

For applying the present rules the mechanisms are classified into groups depending on operating conditions.

The group into which a mechanism is classified is determined by the following factors:

- class of operating time
- load spectrum.

#### 2.1 Class of operating time

The class of operating time indicates the average period per day during which a mechanism is in operation (see table 1). A mechanism is considered to be in operation when it is in motion.

For mechanisms not regularly used during the year the average operating time per day is determined by the ratio of the annual operating time to 250 working days per year.

The higher classes of operating time apply only in such cases where a mechanism is operated during more than one shift per day.

Table 1

Class of operating time	Average operating time per day (in hours)	Calculated total operating time in hours
V0.06 T0	0.12	200
V0.12 T1	0.25	400
V0.25 T2	0.5	800
V 0.5 T3	1	1 600
V 1 T4	2	3 200
V 2 T5	4	6 300
V 3 T6	8	12 500
V 4 T7	16	25 000
V 5 T8	16	50 000

#### 2.2 Load spectrum

The load spectrum indicates to what extent a mechanism or part thereof is subject to maximum stress or whether it is subject to smaller loads only.

For an exact classification into groups the cubic mean value  $k$  referred to the safe working load is required. It is calculated by using the following formula:

$$k = \sqrt[3]{(\beta_1 + \gamma)^3 \cdot t_1 + (\beta_2 + \gamma)^3 \cdot t_2 + \dots + \gamma^3 \cdot t_{\Delta}}$$

where:

$$\beta = \frac{\text{useful or partial load}}{\text{safe working load}}$$

$$\gamma = \frac{\text{dead load}}{\text{safe working load}}$$

$$t = \frac{\text{operating time under useful or partial load and dead load}}{\text{total operating time}}$$

$$t_{\Delta} = \frac{\text{operating time under dead load only}}{\text{total operating time}}$$

Four load spectra are distinguished which are determined by the definitions given and by the ranges covered by the cubic mean values  $k$  as listed in table 2

Table 2

Load spectrum	Definitions	Cubic mean value
1 (light) L1	Mechanisms or parts thereof, usually subject to very small loads and in exceptional cases only to maximum loads	$k \leq 0.50$
2 (medium) L2	Mechanisms or parts thereof, usually subject to small loads but rather often to maximum loads	$0.50 < k \leq 0.63$
3 (heavy) L3	Mechanisms or parts thereof, usually subject to medium loads but frequently to maximum loads	$0.63 < k \leq 0.80$
4 (very heavy) L4	Mechanisms or parts thereof, usually subject to maximum or almost maximum loads	$0.80 < k \leq 1.00$

The formular given above for the cubic mean value  $k$  excludes the weight of the load carrying means. This is acceptable if the ratio

$$\frac{\text{Weight of the load carrying means}}{\text{safe working load}} \leq 0.05$$

Otherwise, the following formula shall be used:

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$$k = \delta \sqrt[3]{(\beta_1 + \gamma + \alpha)^3 \cdot t_1 + (\beta_2 + \gamma + \alpha)^3 \cdot t_2 + \dots + (\gamma + \alpha)^3 \cdot t_\Delta}$$

where  $\alpha = \frac{\text{Weight of the load carrying means}}{\text{Safe working load}}$

$\delta = \frac{\text{Safe working load}}{\text{Lifting power}}$

## 2.3 Definition of terms

2.3.1 The terms used in connection with the load spectrum are defined as follows:

### Load and power variables

Safe working load (SWL) in kg or t	Maximum load (mass) which can be handled by the load carrying means under operating conditions SWL = useful load + deadload
Useful load in kg or t	Useful load which may be handled by using a special sling or attachment, or direct by the load carrying means
Deadload in kg or t	Load carrying attachment + sling
Partial load in kg or t	Part of the useful load
Lifting power in N or kN	Power corresponding to the mass of SWL + load carrying means

### Load handling installations

Load carrying means	Component of the lifting equipment which is connected with the lifting mechanism, used for picking up the load
Sling	Device, which is not a component of the lifting equipment, used for connecting the load carrying means and the useful load or the load carrying attachment
Load carrying attachment	Device, which is not a component of the lifting equipment, used for picking up the useful load and which can be attached to the load carrying means without the need for special modification or assembly work

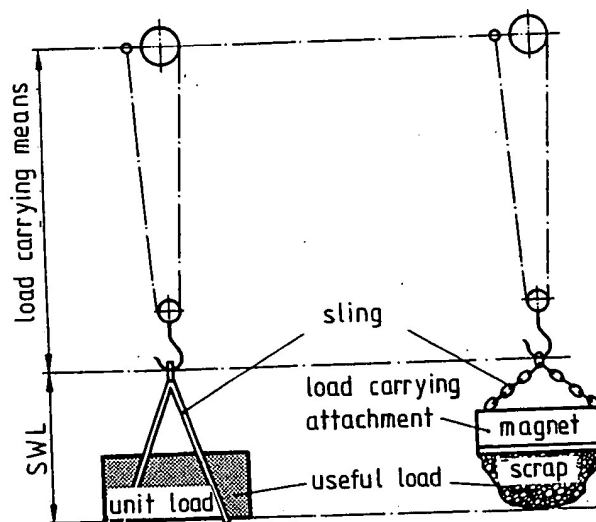


Figure 1.