FEDERATION EUROPEENNE DE LA MANUTENTION
Section IX
SERIES LIFTING EQUIPMENT

FEM
9.512

Rules for the Design of Storage and Retrieval Machines Mechanisms

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Available in German (D), English (E), French (F)
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1 Object and scope

These rules deal with the proper interpretation of safety relevant mechanisms in storage and retrieval machines. To determine a guaranteed theoretical life expectancy for travel and hoist drive units, the mechanisms shall be classified in appropriate groups.

2 Terms and definitions

Load lifted
The load lifted comprises the dead load and the pay or partial load.

Dead load
The dead load comprises the total mass (kg) of the lifting carriage and of its accessories, operator, resistance of the lifting carriage to motion and proportionate weight of the load carrying means (ropes, chains, etc.).

Pay load
The pay load comprises the maximum mass (kg) of the goods to be handled, load make-up accessory (e.g. pallet), packaging material and load safeguarding material (e.g. shrinking foil, etc.).

Dead mass (kg) of the storage and retrieval machines
Mass (kg) of a storage and retrieval machine without payload or partial load.

3 Classification of mechanisms according to operating conditions

The decisive operating conditions for storage and retrieval machines are:

- class of operating time and
- load spectrum

3.1 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). The total operating time in hours is determined by the ratio of the annual operating time to 250 working days per year. A mechanism is considered to be in operation when it is in motion.

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

Class of operating time	Average operating time per day in hours	Calculated total operating time in hours
V 1	≤ 2	3.200
V 2	≤ 4	6.300
V 3	≤ 8	12.500
V 4	≤ 16	25.000
V 5	> 16	50.000

Table 1: Class of operating time

3.2 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 load to be lifted is required. Under the assumption that the life of the mechanism is inversely proportional to the third power of the load it is calculated by using the following formula:

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

In the formula:

$$\beta_i = \frac{\text{Effect of pay or partial load}}{\text{Effect of permissible load}}$$

$$\gamma = \frac{\text{Effect of deadload}}{\text{Effect of permissible load}}$$

$$t_i = \frac{\text{Operating time under pay or partial load}}{\text{Total operating time}}$$

$$t_\Delta = \frac{\text{Operating time under deadload only}}{\text{Total operating time}}$$

Following FEM 9.511, four load spectra are distinguished. For storage and retrieval machines the load spectra listed in table 2 are used, which are determined by the definitions given and by the ranges covered by the cubic mean values k.

Load spectrum	Definitions	Cubic mean value
L 2 (medium)	Mechanisms or parts thereof, rather often subject to maximum loads, but usually to small loads	$0{,}50 < k \leq 0{,}63$
L 3 (heavy)	Mechanisms or parts thereof, often subject to maximum loads and usually to medium loads	$0{,}63 < k \leq 0{,}80$
L 4 (very heavy)	Mechanisms or parts thereof, usually subject to almost maximum loads	$0{,}80 < k \leq 1{,}00$

Table 2: Load spectrum

The limit values listed in table 2 for the cubic mean values of k can be calculated from the following ideal load spectra: