



SECTION II

DE LA FEDERATION EUROPEENNE DE LA MANUTENTION
STETIGFÖRDERER • MANUTENTION CONTINUE • CONTINUOUS HANDLING

39/41, rue Louis Blanc - 92400 Courbevoie
☒ 92038 Paris La Défense cedex, France
tél. 01 47 17 63 35 - télécopie 01 47 17 63 30

RULES FOR THE DESIGN OF MOBILE EQUIPMENT FOR CONTINUOUS HANDLING OF BULK MATERIALS

1997



SECTION II

DE LA FEDERATION EUROPEENNE DE LA MANUTENTION
STETIGFÖRDERER • MANUTENTION CONTINUE • CONTINUOUS HANDLING

Secrétaire : Madame E. A. Codevelle
39/41, rue Louis Blanc, 92400 Courbevoie
☒ 92038 Paris - La Défense cedex, France
tél. 33 (0)1 47 17 63 27 - télécopie 33 (0)1 47 17 63 30

RULES FOR THE DESIGN OF MOBILE EQUIPMENT FOR CONTINUOUS HANDLING OF BULK MATERIALS

DOCUMENT 2 131 / 2 132

GENERAL SUMMARY

chapter 1	Scope and field of application	p 1-1 to 1-12
chapter 2	Classification and loading of structures and mechanisms	p 2-1 to 2-45
chapter 3	Calculating the stresses in structures	p 3-1 to 3-83
chapter 4	Calculation and choice of mechanisms components	p 4-1 to 4-34
chapter 5	Safety requirements	p 5-1 to 5-2
chapter 6	Tests and tolerances	p 6-1 to 6-19

edition 1997

Chapter 1

SCOPE AND FIELD OF APPLICATION

CHAPTER 1

SCOPE AND FIELD OF APPLICATION

CONTENTS

	<u>Clause</u>	<u>Page</u>
Foreword and general contents	1-1	1-3
Introduction	1-2	1-5
Scope of the rules	1-3	1-6
Field of application	1-4	1-6
List of main symbols and notations	1-5	1-8

1-1 FOREWORD AND GENERAL CONTENTS

The rules for the design of mobile equipment for continuous handling of bulk materials developed by the Technical Committee of FEM Section II have always been widely used in many countries throughout the world.

It should be mentioned that, since its January 1978 edition, the document FEM 2 131 - 01/1978 has been adopted as an ISO international standard under the reference ISO 5049/1. It shall be proposed for this ISO standard a revision to include the corresponding chapters of the present FEM edition.

The revision done in 1997 does not bring fundamental changes to the 1992 edition. The important modifications deal with the following points :

- fatigue calculation of mechanisms,
- friction resistances to define drive mechanisms and braking devices,
- tables describing cases of notch effect for welded structure.

In order to keep the history of the evolution of these rules which apply to the machines defined below in the clause "Scope", it has been indicated below what are the added values of the 1992 edition to the documents :

- a) FEM 2 131, edition January 1978 "Rules for the design of mobile continuous bulk handling equipment - chapter I Structures",
- b) FEM 2 132, edition June 1977 "Rules for the design of mobile continuous bulk handling equipment - chapter II Mechanisms".

FEM Section II had decided to issue the 1992 edition of these design rules with a threefold objective :

- 1) to make the periodical revision of the above rules to update them,
- 2) to add chapters in particular on safety, tests and tolerances,
- 3) to harmonize them, as far as possible, with the third edition of the design rules issued by FEM Section I in 1988 for the design of lifting appliances.

The following comments can be made on the three objectives which are at the origin of the 1992 edition :

1) Revision of the rules FEM 2 131 - FEM 2 132

The 1992 periodical revision did not involve fundamental changes, but was an updating which essentially took into account the changes brought in other standards with regard for example to units, welding symbols, etc.

2) Additions to the previous edition

The 1992 edition had been completed with two chapters covering :

- safety requirements (chapter 5)
- tests and tolerances (chapter 6)

It was planned to add an "Electrical" chapter in a next edition.

3) Harmonization with the 3rd edition of FEM Section I design rules for lifting appliances

Design departments which have to design both handling equipment (FEM Section II rules) and lifting equipment (FEM Section I rules) have sometimes met difficulties due to a certain lack of consistency between the corresponding rules.

While it should be pointed out that continuous handling equipment and lifting appliances are different with regard to the definition of loads and their combinations, it should be noted, on the other hand, that the method of classification of the machines, of their mechanisms or components, and the calculation of certain elements, should be similar if not identical.

The 1992 edition therefore tries to be in harmony with FEM Section I design rules to the greatest possible extent. Some differences however remain : it may be possible to reduce them later when the results of many studies currently in progress (calculation for fatigue, definition of rail wheels, calculation of wind effects,...) are known.

4) Major changes in the documents FEM 2 131 and 2 132 editions of 1978 and 1977 respectively

It should be stressed that the 1992 version of the design rules for continuous bulk handling equipment does not include any major changes in its content compared to the previous edition which consisted of documents FEM 2 131 and 2 132.

In particular, the definition of the loads applying on machines and the combination of loads have been maintained for the most part.

The principal changes can be summarized as follows :

- Classification of the machines, their mechanisms and components

Groups have been created to facilitate dialogue between user and manufacturer. As far as the whole machine is concerned, these groups called A2 to A8 are directly based on the total desired duration of utilization.

Mechanisms can be classified in eight groups called M1 to M8, each group being based on a spectrum class on one hand and a class of utilization (i.e. on a total duration of utilization) on the other hand.

Structural or mechanism components can be classified in eight groups named E1 to E8, each of them being based, in the same way as mechanisms, on a class of load spectrum and a class of utilization.

- Loads to be taken into account in the calculation of structures

Clarifications have been made regarding the definition of these loads, in particular on the subject of wind loads. A load case has been added for special situations which may occur for machines during erection.

- Calculating the stresses in structural components

A method for selecting the steel grade in relation to brittle fracture has been added : the choice is to be made between four quality groups which are distinguished by the impact strength of the corresponding steels.

The chapter on bolted joints has been reworked and completed.

The curves giving the permissible fatigue stresses for structural components have been maintained and given in relation to the component classification group.

- Checking and choice of mechanism components

Wire ropes are chosen on the basis of a practical safety factor which depends on the mechanism classification group. The rope breaking strength takes into account the rope fill factor and spinning loss factor.

Regarding the choice of rail wheels, the factor C_2 is given in relation to the class of utilization of the mechanism and not the classification group, in order to keep the method used so far which is fully satisfactory.

To conclude the summary of the major changes introduced in 1992 to the previous edition (documents FEM 2 131 and 2 132), it is worthwhile noting that the changes made during the elaboration of the standard ISO 5049/1 published in 1994 (which reproduced the FEM rules 2 131), have of course been incorporated in the 1992 edition.

1-2 INTRODUCTION

To facilitate the use of these rules by the purchasers, manufacturers and safety organizations concerned, it is necessary to give some explanation in regard to the two following questions :

- How should these rules be applied in practice to the different types of appliance whose construction they cover ?
 - How should a purchaser use these rules to define his requirements in relation to an appliance which he desires to order and what conditions should he specify in his enquiry to ensure that the manufacturers can submit a proposal in accordance with his requirements ?
- 1) First of all, it is necessary to recognize the great variety of appliances which are covered by the design rules. It is obvious that a bucket-wheel reclaimer used for very high duty in a stockyard is not designed in the same manner as a small stacker for infrequent duty. For the latter, it may not be necessary to make all the verifications which would appear to be required from reading through the rules, because one would clearly finish with a volume of calculations which would be totally out of proportion to the objective in view.

The manufacturer must therefore decide in each particular case which parts of the new machine, should be analysed and which parts can be accepted without calculation. This is not because the latter would contravene the requirements of the rules but because, on the contrary, due to experience, the designer is certain in advance, that the calculations for the latter would only confirm a favourable outcome. This may be because a standard component is being used which has been verified once and for all or because it has been established that some of the verifications imposed by the rules cannot, in certain cases, have an unfavourable result and therefore serve no purpose.

With the fatigue calculations, for example, it is very easy to see that certain verifications are unnecessary for appliances of light or moderate duty because they always lead to the conclusion that the most unfavourable cases are those resulting from checking safety in relation to the elastic limit or to the breaking stress.

These considerations show that calculations, made in accordance with the rules, can take a very different form according to the type of appliance which is being considered, and may, in the case of

a simple machine or a machine embodying standard components, be in the form of a brief summary without prejudicing the compliance of the machine with the principles set out by the design rules.

- 2) As far as the second question is concerned, some explanation is first desirable for the purchaser, who may be somewhat bewildered by the extent of the document and confused when faced with the variety of choice which it presents, a variety which is, however, necessary if one wishes to take account of the great diversity of problems to be resolved.

In fact, the only important matter for the purchaser is to define the duty which is to be expected from the appliance and if possible to give some indication of the duty of the various individual motions.

As regards the service to be performed by the appliance, only one factor must be specified, i.e. the class of utilization, as defined in 2-1.2.2. This gives the group in which the appliance must be ranged.

In order to obtain the number of hours which determines the class of utilization, the purchaser may, for instance, find the product of :

- the average number of hours which the appliance will be used each day,
- the average number of days of use per year,
- the number of years after which the appliance may be considered as having to be replaced.

In the case of mechanisms, the following should also be specified :

- the class of utilization, as defined in 2-1.3.2,
- the load spectrum, as defined in 2-1.3.3.

On the basis of the class of utilization of the appliance as a whole, it is possible to determine a total number of working hours for each mechanism according to the average duration of a working cycle and the ratio between the operating time of the mechanism and the duration of the complete cycle. An example of classification of an appliance, its mechanisms and elements is given in 2-1.5.

As a general rule, the purchaser need not supply any other information in connection with the design of the appliance, except in certain cases : e.g. the value of the out-of-service wind, where local conditions are considered to necessitate design for an out-of-service wind greater than that defined in 2-2.3.6.

1-3 SCOPE OF THE RULES

The purpose of these rules is to determine the loads and combinations of loads which must be taken into account when designing handling appliances, and also to establish the strength and stability conditions to be observed for the various load combinations.

1-4 FIELD OF APPLICATION

These rules are applicable to mobile equipment for continuous handling of bulk materials, especially to rail-mounted :

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> - stackers - shiploaders - reclaimers - combined stackers and reclaimers - continuous ship unloaders | } | equipment fitted with bucket -wheels or bucket chains |
|--|---|---|

For other equipment, such as :

- excavators,
- scrapers,
- reclaimers with scraper chains,
- tyre or crawler-mounted stackers and/or reclaimers,

the clauses in these design rules appropriate to each type of apparatus are applicable.

It should be noted that when a mobile machine includes one or several belt conveyors as conveying elements, the clauses of these design rules, insofar as they apply to the machine in question, are applicable. The selection of the conveyors should be made in accordance with the standard ISO 5048 : "Continuous mechanical handling equipment - Belt conveyors with carrying idlers - Calculation of operating power and tensile forces".

On the other hand, belt conveyors which are not part of a mobile machine are excluded from the scope of these design rules.