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European Safety Promotion Network – Rotorcraft (ESPN-R) Sling Load Operations Safety Promotion

ERFA 2021

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D. Francescatti & M. Behrens
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Agenda

- Introduction
- Task Force
- LinkedIn Group
- Need for an ESPN-R Sling Load Operation
- Operational topic
- Regulation Baseline

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ESPN-R Sling Load Operations Safety Promotion

Introduction

Introduction

European
Safety
Promotion
Network
Rotorcraft
TO SERVE THE COMMUNITY

- How to promote the “lesson learned” within the community
  - Collect occurrences and risk from experts
  - Evaluate the risk mitigation possibilities based on the root causes for issues, incidents or accidents
  - With the target to develop best practices and tackle the key areas from these occurrences

These findings should not be read as apportioning blame or liability to any particular organization or individual.

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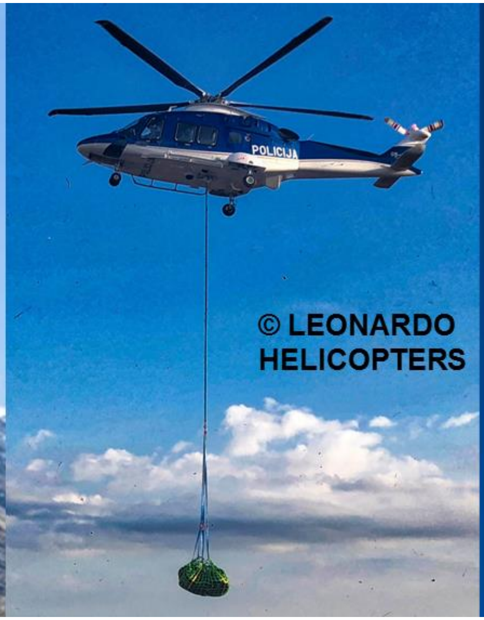
Task Force

Task Force

- **Task force** team has been established with a mixed committee from
  - Authorities
  - Industry (OEMs and Operators)

Same approach as with the hoist safety promotion task force



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LinkedIn Group

LinkedIn Group

- ESPN-R Sling Load Operations Safety Promotion LinkedIn Group has been established under
  https://www.linkedin.com/groups/8989107/

  - The task force achieved a big leap and is very pleased to see that the LinkedIn Group now
    counts 125 members

  - **Feel free to join**

  - Please join later on and any comment is more than welcome.

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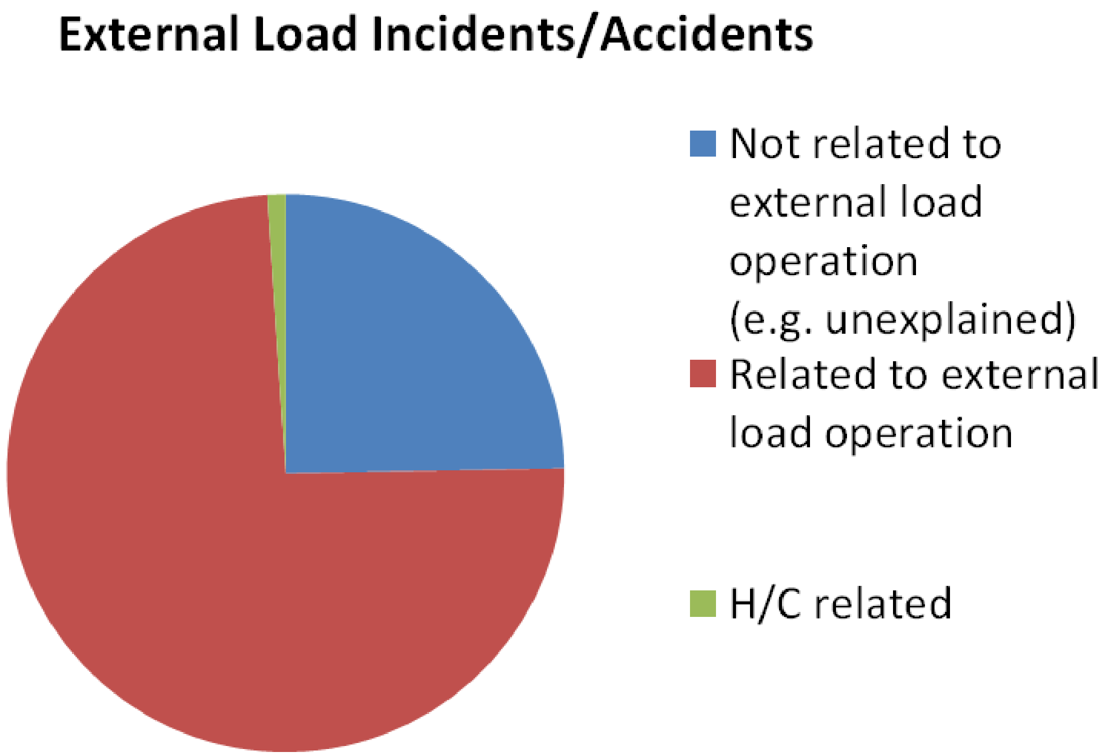
Need for an ESPN-R

Need for an ESPN-R Sling Load Operations Safety Promotion

- An assessment has been performed in order to show the operational occurrence distribution.
- **This chart confirms that most of the occurrences are related to the operation**.
- **Maintenance and missing of training is still (unfortunately) the cause of a significant number of accidents and incidents for helicopters.**



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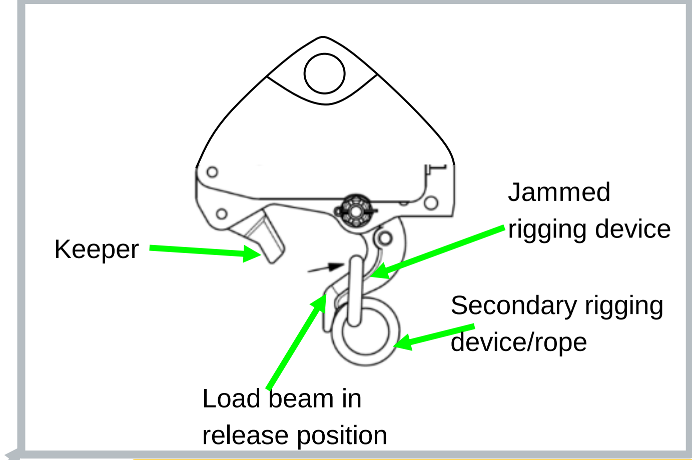
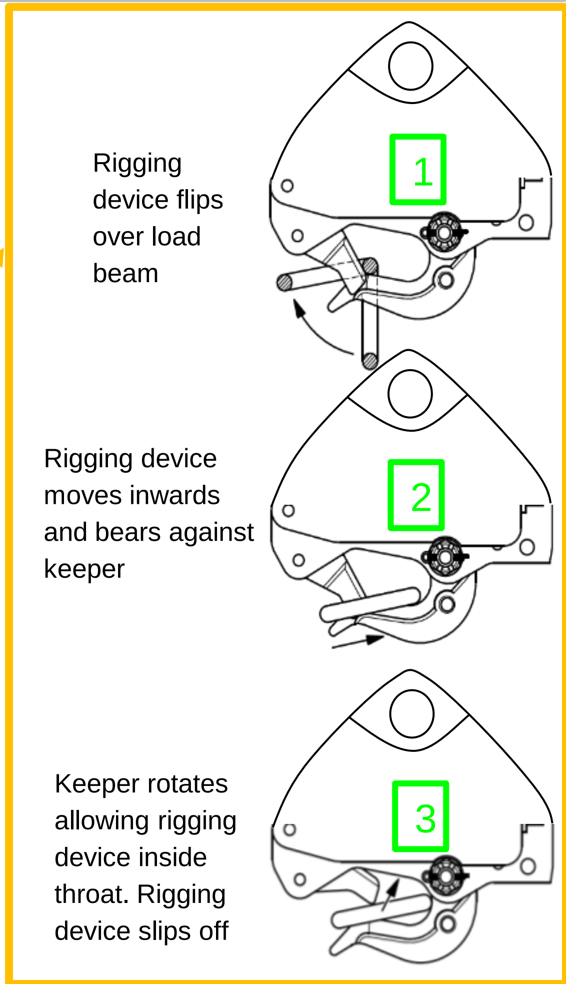
Operational topics

Operational topics: Cargo Hook Interface



- **Source/Background:**
  - CS-27/29.865 C(8)i.
    - The Cargo hook manufactures specify particular shapes, sizes, and cross sections for lifting eyes to assure compatibility with their hook design.
  - EASA AD PAD No.: 15-117
  - EASA CM-CS-005

- **Discussion:**
  - Experience has shown that, under certain conditions, a load may inadvertently
    - hang up because of improper geometry at the hook-to-eye interface that will not allow the eye to slide off an open hook as intended.
    - release (dynamic roll-out) typically occurs when either the sling or harness is not properly attached to the hook, is blown by down draft, is dragged along the ground or through water, or is otherwise placed into a dangerous hook-to-eye configuration.
  - Any textile interface (non rigid) should not been used directly on the load beam. This based on the assumption that:
    - High friction between the load beam and the sling which could limit the clean separation of the rigging device
    - Any sharp edge on the load beam, e.g. caused by a steel shackle could damage the non rigid rigging interface.

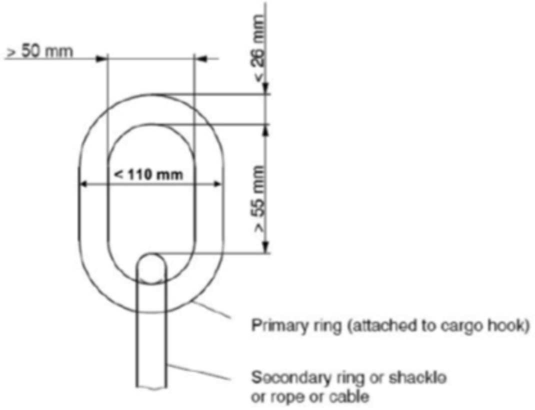


Operational topics: Cargo Hook Interface Conclusion

- Add a check point inside the SOP (Standard Operating Procedures), taken into account the rigging interface dimension.

- Do not use a non rigid rigging items inside the cargo hook

Possible sketch for LinkedIn



This is common to all cargo hooks, not only the one shown on the picture

ESPN-R Sling Load Operations Safety Promotion

Regulations baseline

Design Approval of sling load equipment

- NHEC (Non Human External Cargo)
  - – Design approval according to the CS27/29 for NHEC is limited to the primary cargo hook
  - – Anything for NHEC operation below or attached to the primary cargo hook is not part of the H/C design approval.
- HEC (Human External Cargo)
  - – The design approval of a PCDS (Personnel Carrying Device System) is divided in
    - – Complex if more than 2 person (in general)
      - – Design approval according CS27/29.
    - – Non Complex

- Aircraft primary cargo hook covered by Type Certification of H/C manufacturer according to CS27/29.

- Any load, could be HEC/NHEC covered by STC or PCDS or machinery norm.
- Interface definition defined in the FLM, item can be covered by PCDS-STC or machinery norm for NHEC.
- Liable should be the operator.

Airworthiness Requirements

CS* **Certification Specification for**	**27** **Small Rotorcraft**	**Europe**
	29 **Large Rotorcraft** (> 3175 kg)	
FAR* **Federal Aviation Requirements for**	**27** **Small Rotorcraft**	**USA**
	29 **Large Rotorcraft** (> 3175 kg)	

*Advisory Circular (AC)
Provides acceptable means of compliance for
the different requirements out of the FAR and CS.

PDF-Datei

- Acceptable means of compliance specially for the external loads are defined under § 27/29.865

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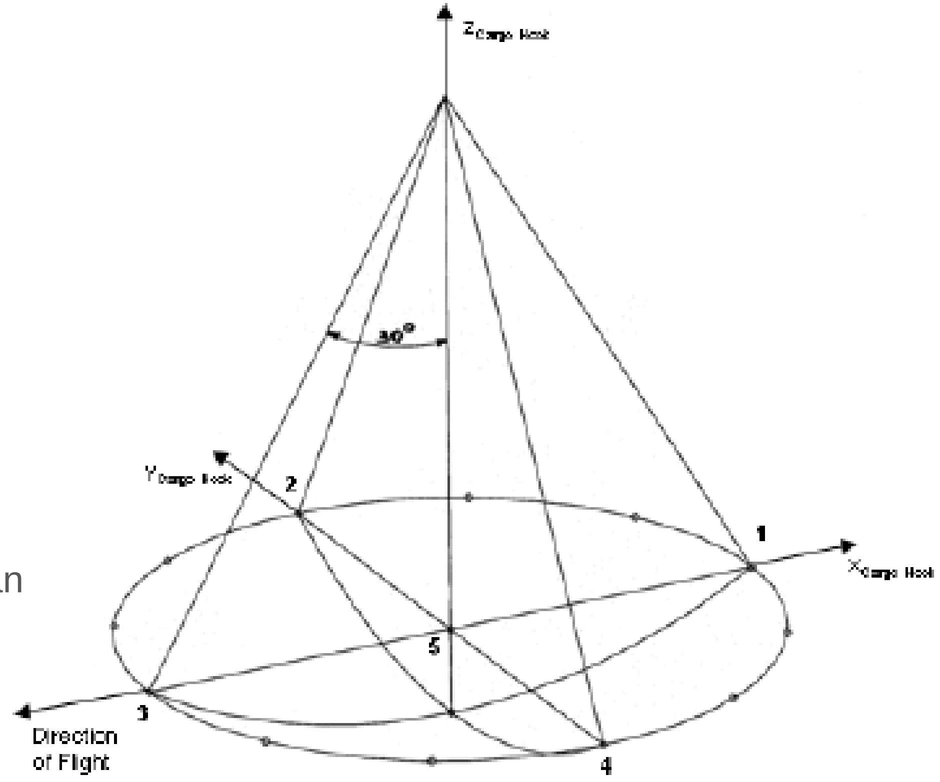
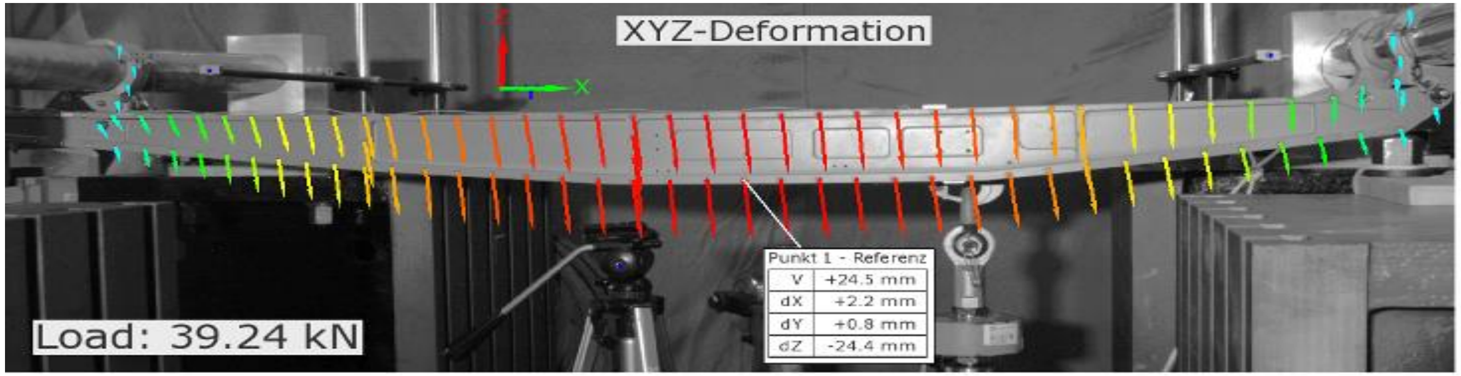
Airworthiness Requirements

- Main Regulation Restraints from FAR/CS 27 or 29:
  - **§865 EXTERNAL LOADS**
    - a)
      - **NHEC** (Non Human External Cargo)
        Limit static load 2.5g – ultimate load 2.5x**1.5**=**3,75g**
        To be applied in any direction making the maximum angle with the vertical that can be achieved in service but not less than 30º
      - **HEC** (Human External Cargo)
        Limit static load 3.5g – ultimate load 3.5x**1.5**=**5,25g**
        To be applied in any direction making the maximum angle with the vertical that can be achieved in service but not less than 30º





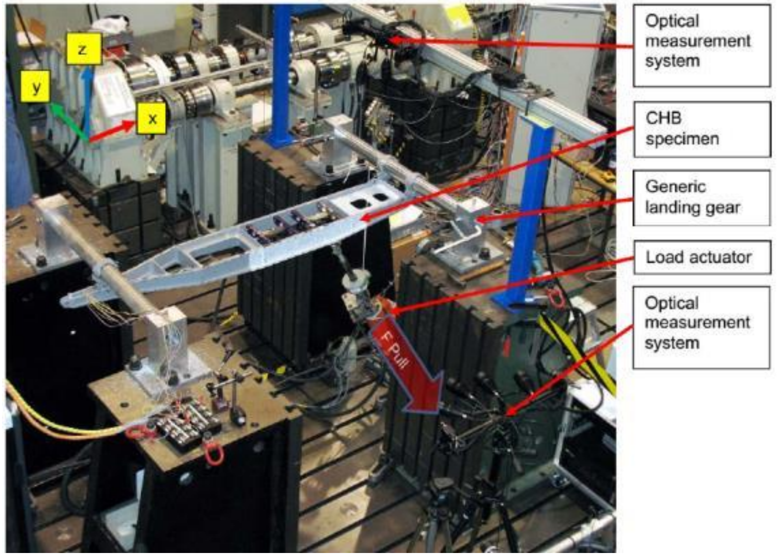
Common example

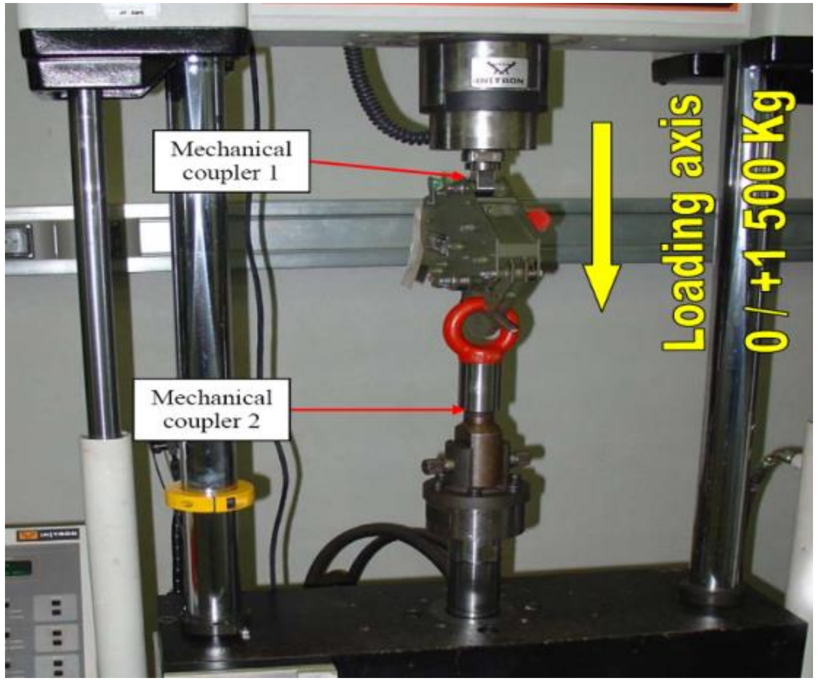
Rated Load NHEC	Limit Load	Ultimate Load
1600kg (~16kN)	**4000kg (~40kN)**	**6000kg (~60kN)**

Airworthiness Requirements

- Main Regulation Restraints from FAR/CS 27 or 29:
  - **§865 EXTERNAL LOADS**
    - f) Fatigue evaluation (refers to §571)
      - Is mandatory for HEC
      - Nevertheless in AH it is common to apply fatigue substantiate for NHEC
  - **§571 Fatigue tolerance evaluation of metallic structure**
    - a) A fatigue tolerance evaluation of each Principal Structural Element (PSE) must be performed, and appropriate inspections and retirement time or approved equivalent means must be established to avoid Catastrophic Failure during the operational life of the rotorcraft.

The retirement time is based on safe life evaluation of each fatigue loaded part, the failure of which could lead to loss of load. In addition, flaw tolerant safe-life substantiations have been performed to provide a safe period of operation of structure with clearly detectable flaws within routine inspection period. The types of flaws considered include intrinsic/discrete flaws, impacts, scratches, corrosion and fretting (influence of fretting is considered the component full scale fatigue test). The full scale test has been performed without flaws, the effect of the flaws has been therefore considered by a severe strength-reduction effect, as determined by a flawed coupon test program.





Airworthiness Requirements

- Main Regulation Restraints from FAR/CS 27 or 29:

CS 29.619 Special factors

(a) The special factors prescribed in CS 29.621 to 29.625 apply to each part of the structure whose strength is:

(1) Uncertain;

(2) Likely to deteriorate in service before normal replacement; or

(3) Subject to appreciable variability due to:

(i) Uncertainties in manufacturing processes; or

(ii) Uncertainties in inspection methods.

CS 29.625 Fitting factors

For each fitting (part or terminal used to join one structural member to another) the following apply:

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1.15 must be applied to each part of:

Both options: with & without test

CS 29.621 Casting factors

Casting factor	Inspection
2.0 or greater ……..	100% visual.
Less than 2.0 greater than 1.5	100% visual, and magnetic particle (ferromagnetic materials), penetrant (non ferro-magnetic materials), or approved equivalent inspection methods.
1.25 through 1.50......	100% visual, and magnetic particle (ferromagnetic materials), penetrant (non ferro-magnetic materials), and radiographic or approved equivalent inspection methods.

CS 29.623 Bearing factors

(a) Except as provided in sub-paragraph (b), each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used on a part for which any larger special factor is prescribed.

Fatigue Life Prediction

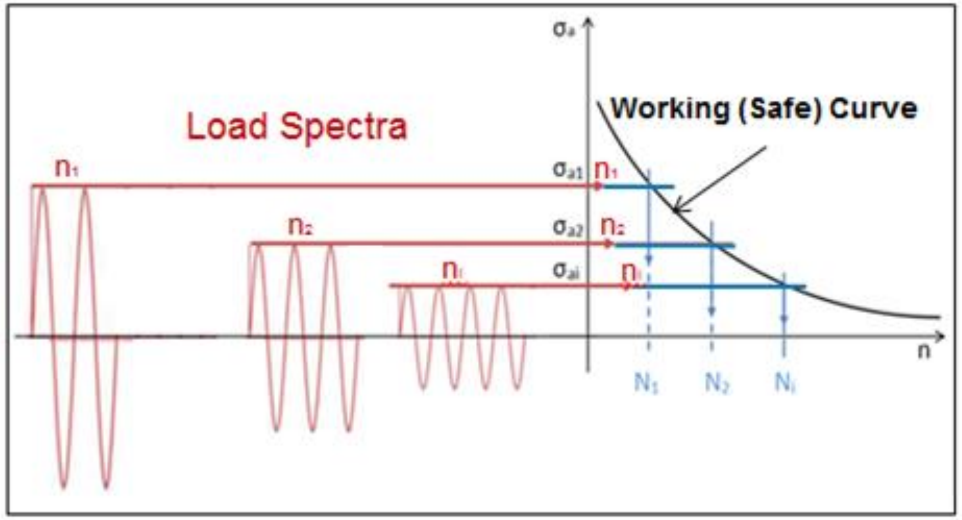
Miner`s Rule

The evaluation of fatigue is based on the assumption that **every load step i** of the idealized spectrum leads to a **partial damage Di** which is given as

$\mathbf{Di} = \frac{ni}{Ni}$

The retirement time of the part is when **total damage D** reaches the value of **1** (when the damage results in a failure)

$$D = \sum \frac{n}{N} = \frac{n1}{N1} + \frac{n2}{N2} + \frac{ni}{Ni} = 1$$



Accumulation of Damage up to crack initiation according to Miner

step i	$\sigma_{m,i}$ [MPa]	$\sigma_{a,i}$ [MPa]	n_i [cycles]	N_i [cycles][a]	D_i [-]
1	100.00	160.00	10	7,456	0.00134
2	100.00	150.00	20	9,618	0.00208
3	90.00	140.00	50	13,388	0.00373
4	82.50	132.50	180	17,402	0.01034
5	74.75	124.75	520	23,238	0.02238
6	67.00	117.00	1,520	31,791	0.04781
7	59.25	109.25	8,000	44,935	0.17804
8	51.50	101.50	29,700	66,374	0.44746
sum			40,000		0.71318

$$FH = \frac{10000}{0.7318} = 13665$$

Lifetime

D @10000 FH (because in this example the basis for the load spectrum is 10000 FH)

Thank you