
Condition and Performance Monitoring of Bridges, Viaducts and Railway Structures

Helmut **WENZEL**

January 2016, Bangkok, Thailand

SHManager®



Protecting our Infrastructure

Aswan Bridge / Jan. 2013



Excessive Loads



Heavy Loads (505t) – no collapse or damage Real-time Assessment

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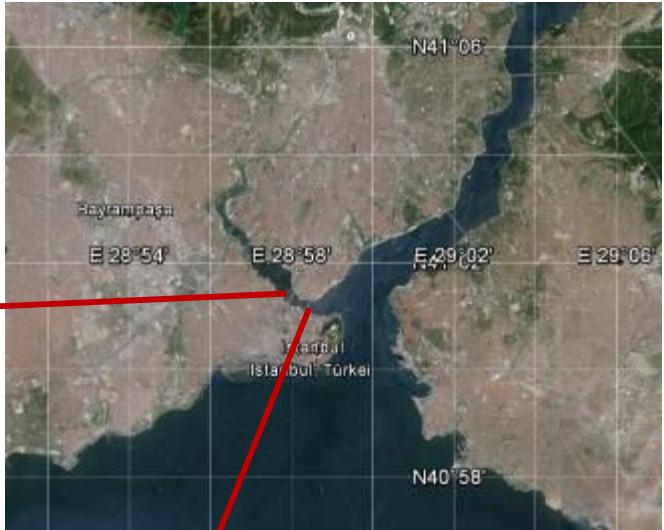




P
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Effects on Bridges: Earthquakes

Istanbul – Golden Horn

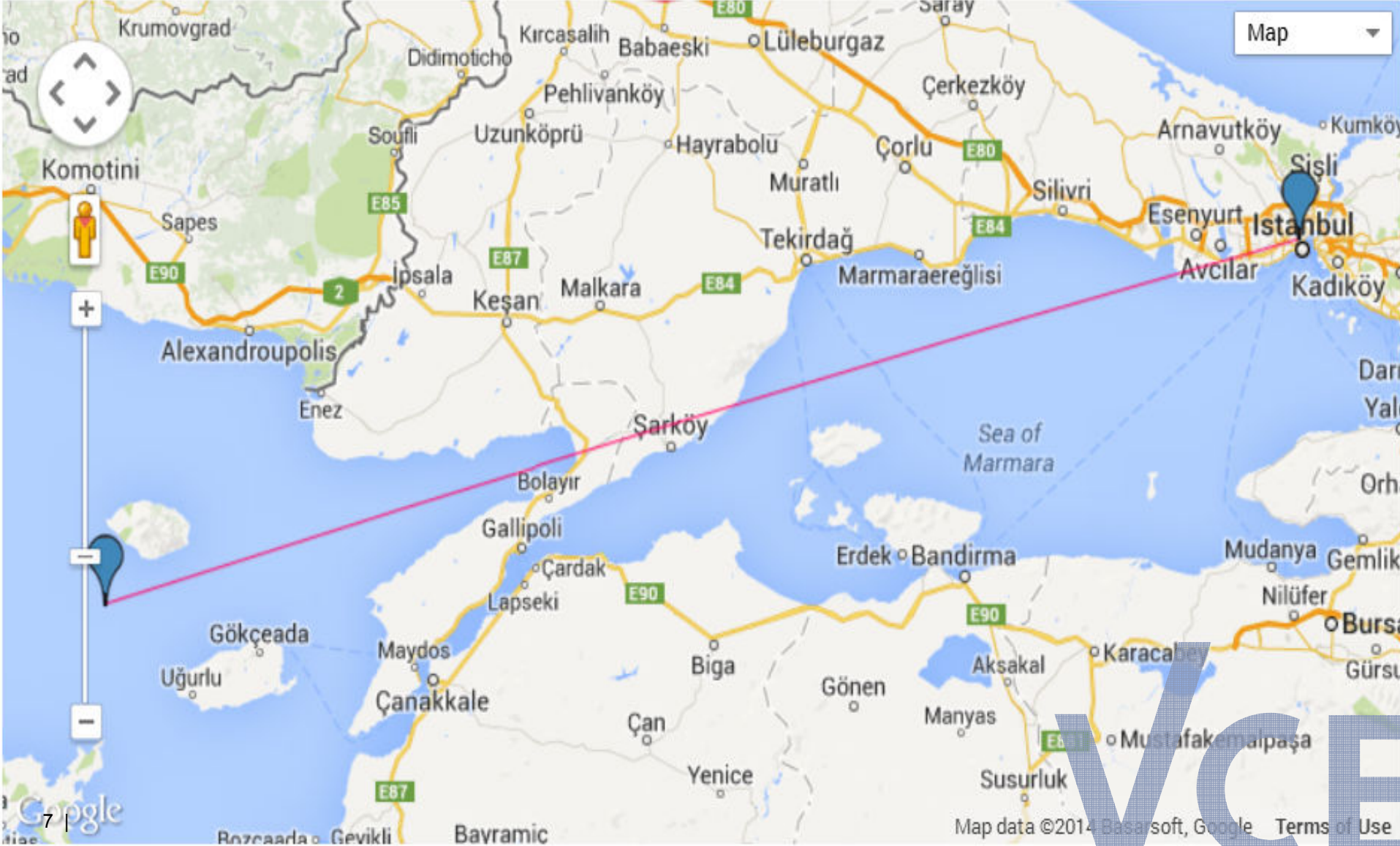


Halic Metro Bridge Operation and Rotation Tests



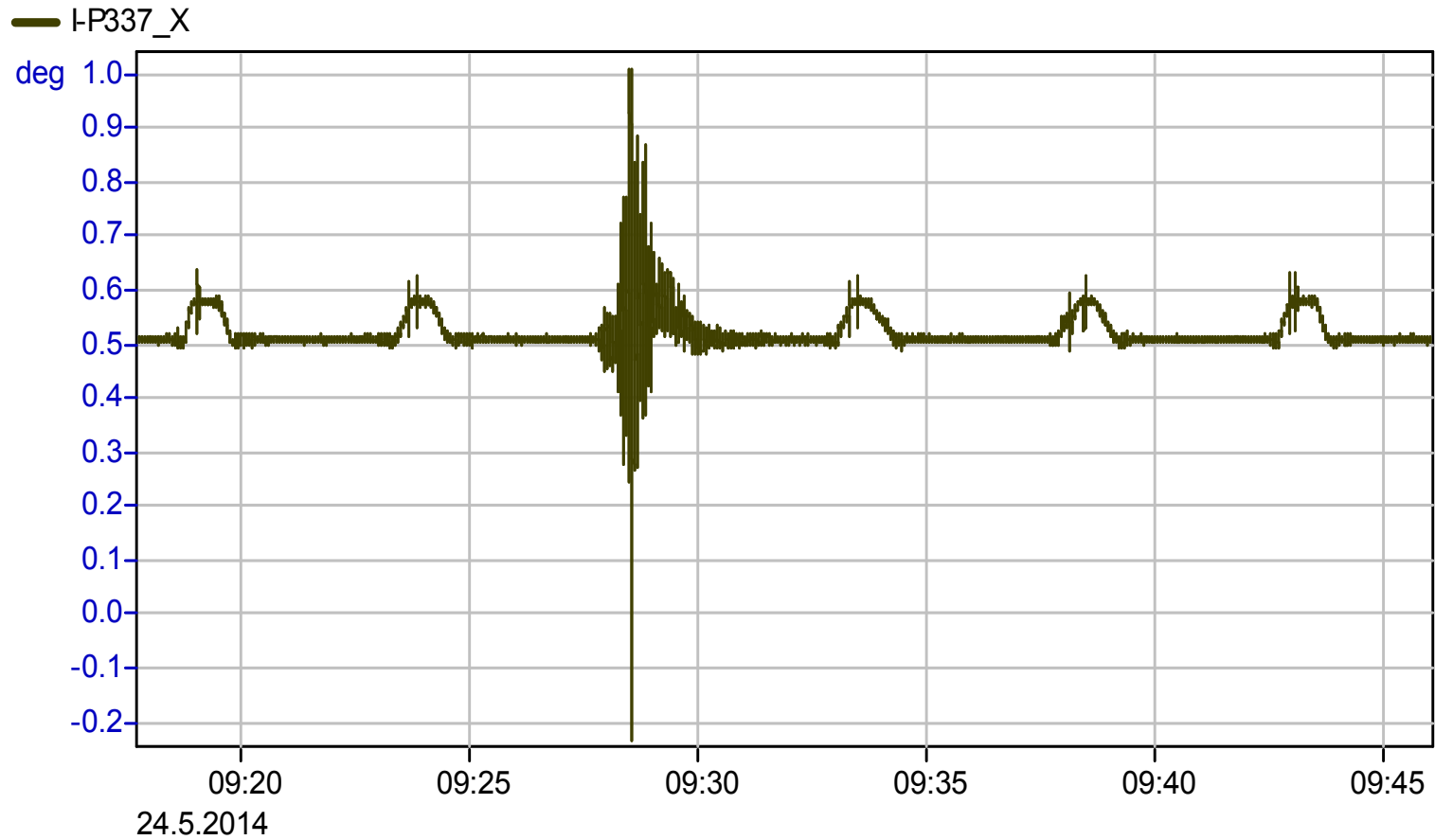
Halic Metro Bridge

Monitoring Facts and Figures



Halic Metro Bridge

Monitoring Facts and Figures

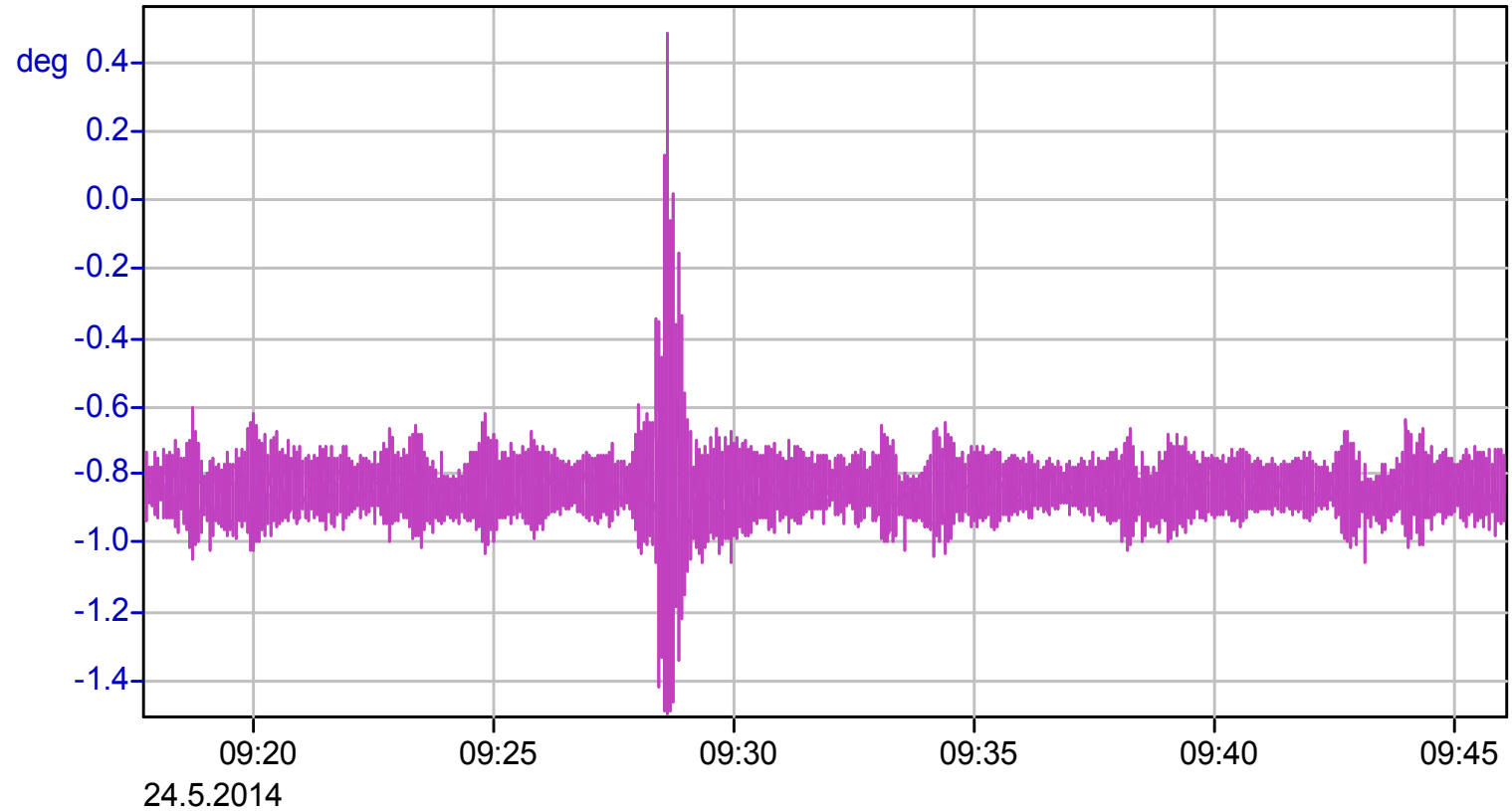


Halic Metro Bridge

Monitoring Facts and Figures



I-P33-top_X

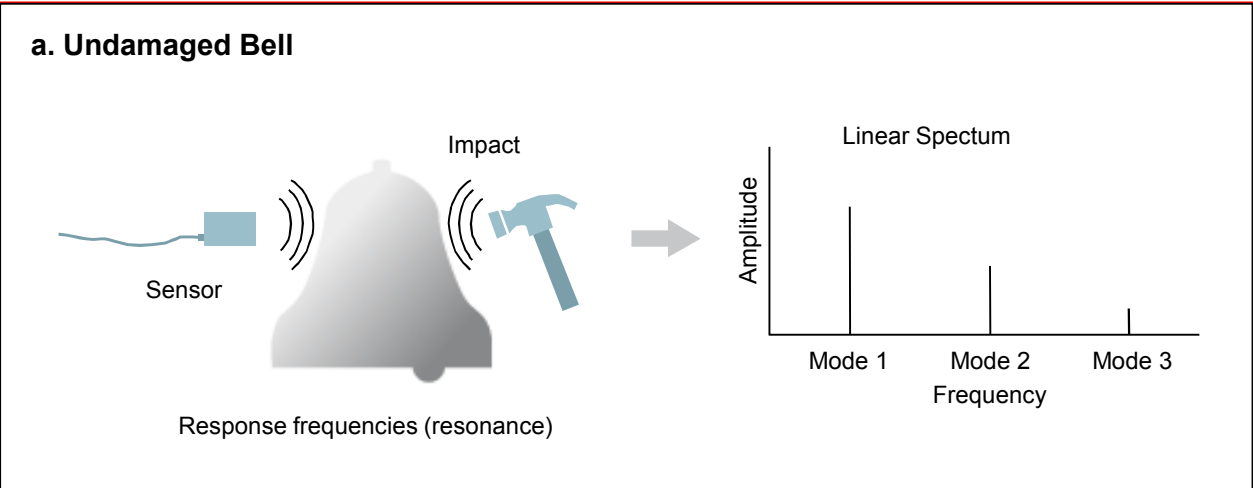


Halic Metro Bridge

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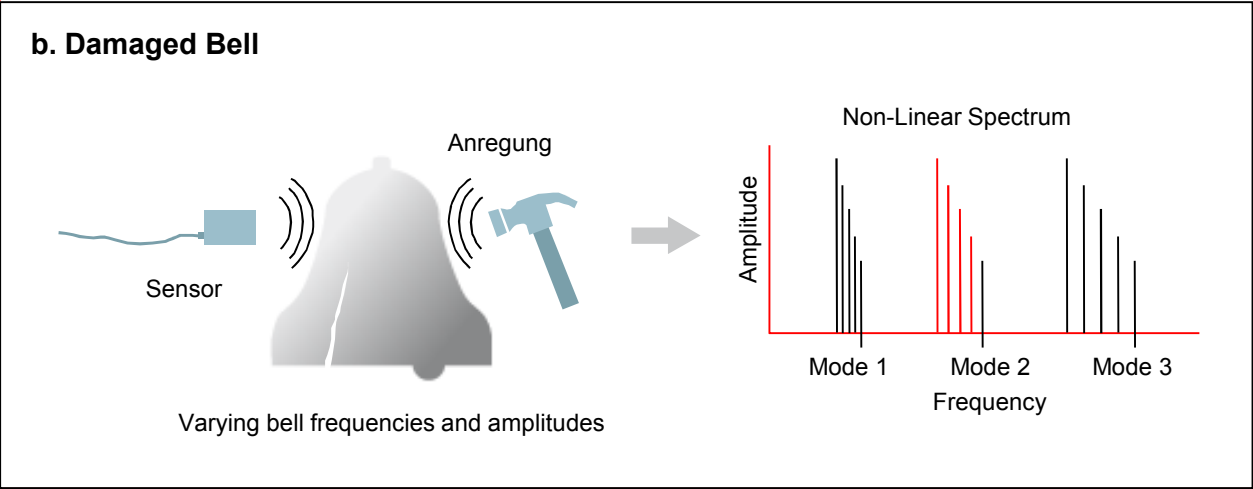


Background: Why Dynamic Monitoring ?

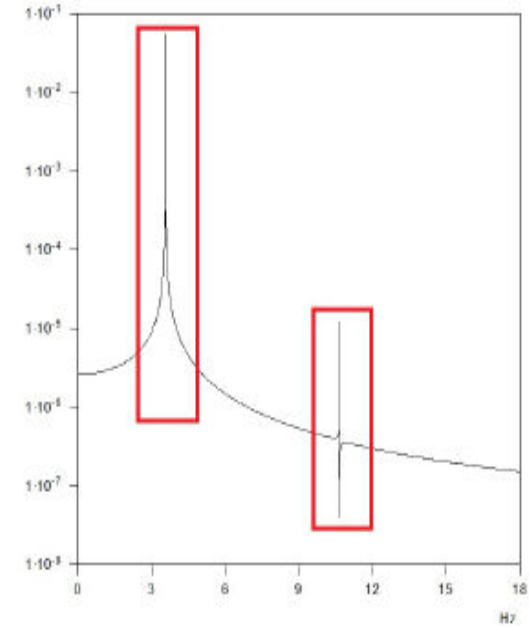
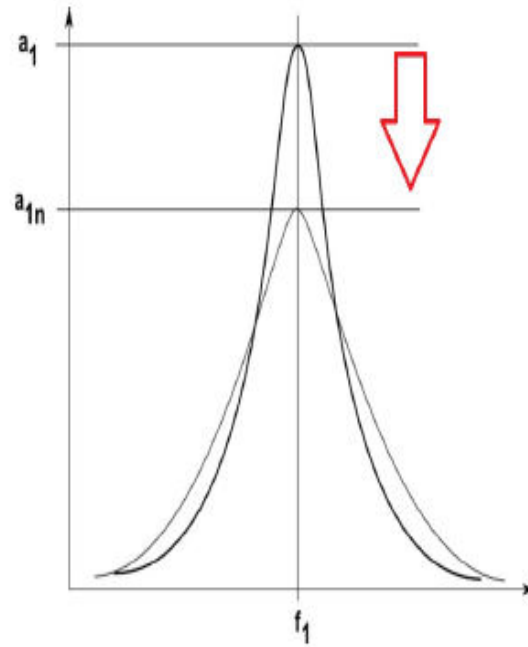
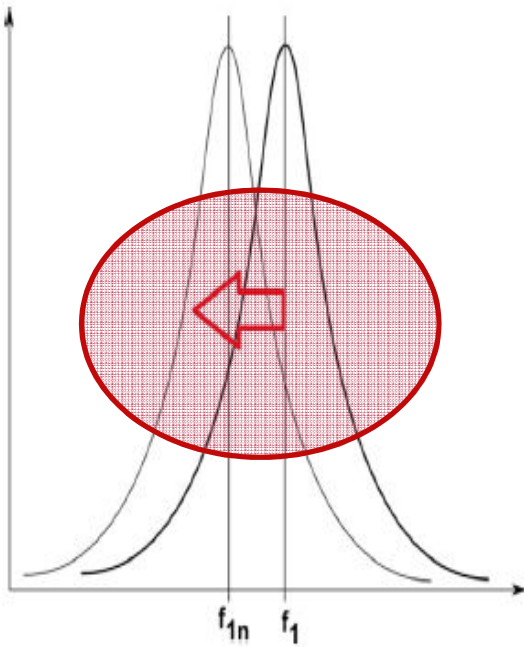


Shadow
Frequencies

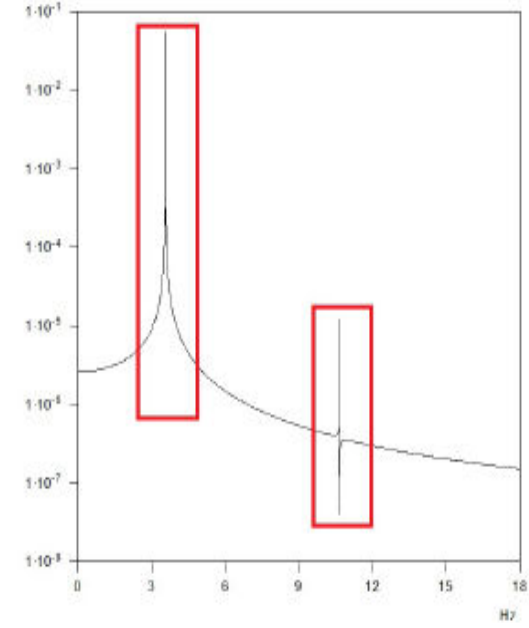
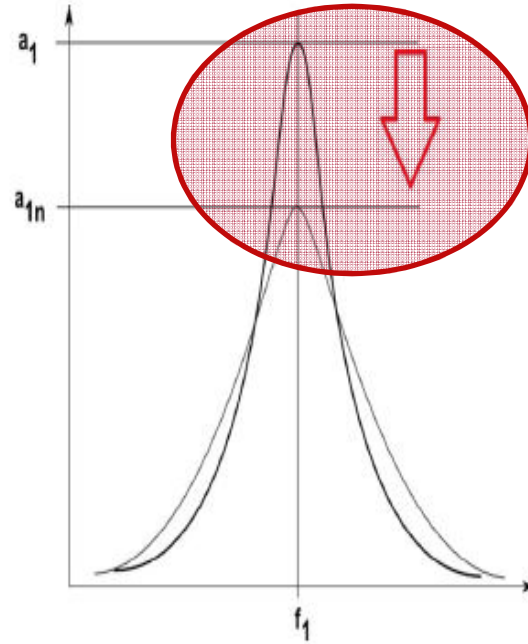
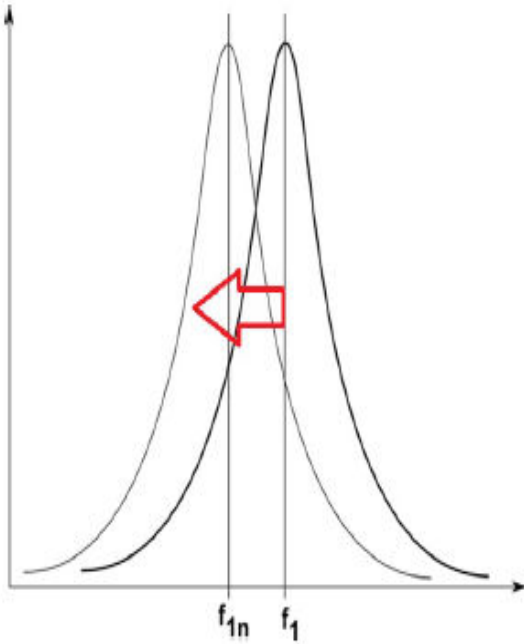
Indicate
Damage



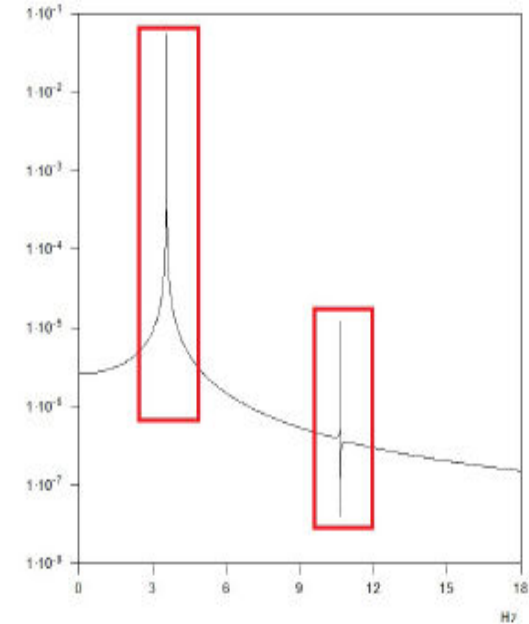
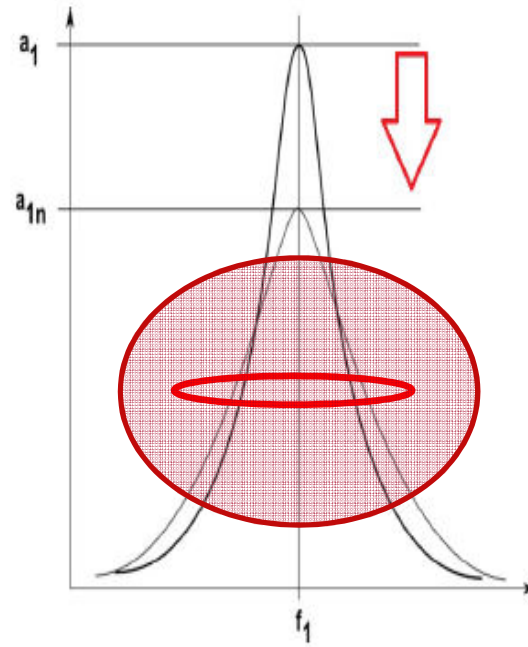
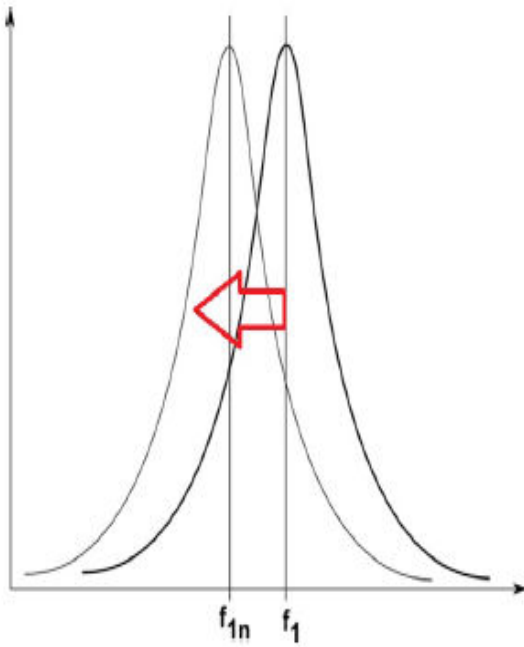
Parameter vs Key Performance Indicators



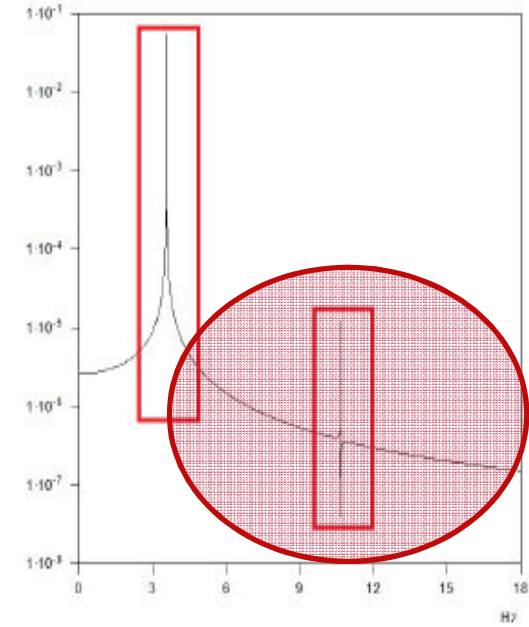
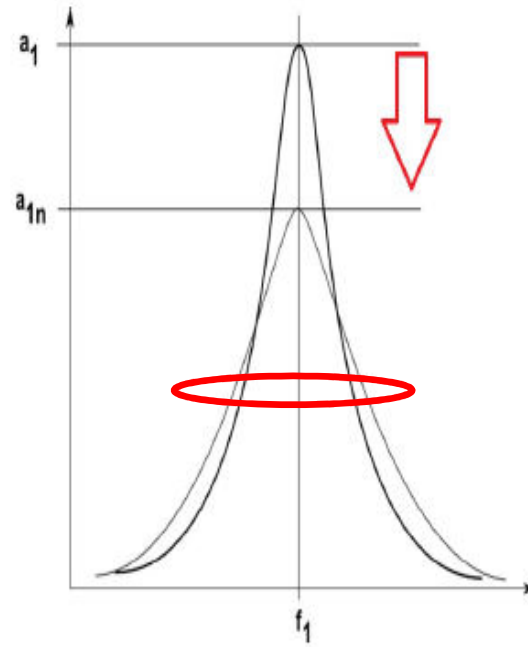
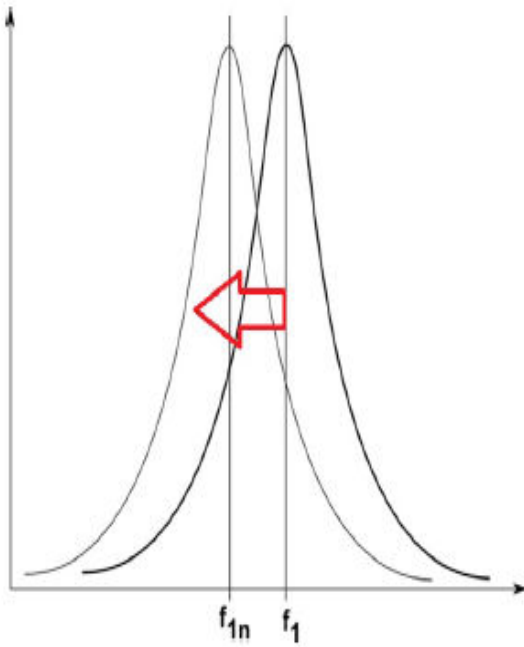
Parameter vs Key Performance Indicators



Parameter vs Key Performance Indicators



Parameter vs Key Performance Indicators

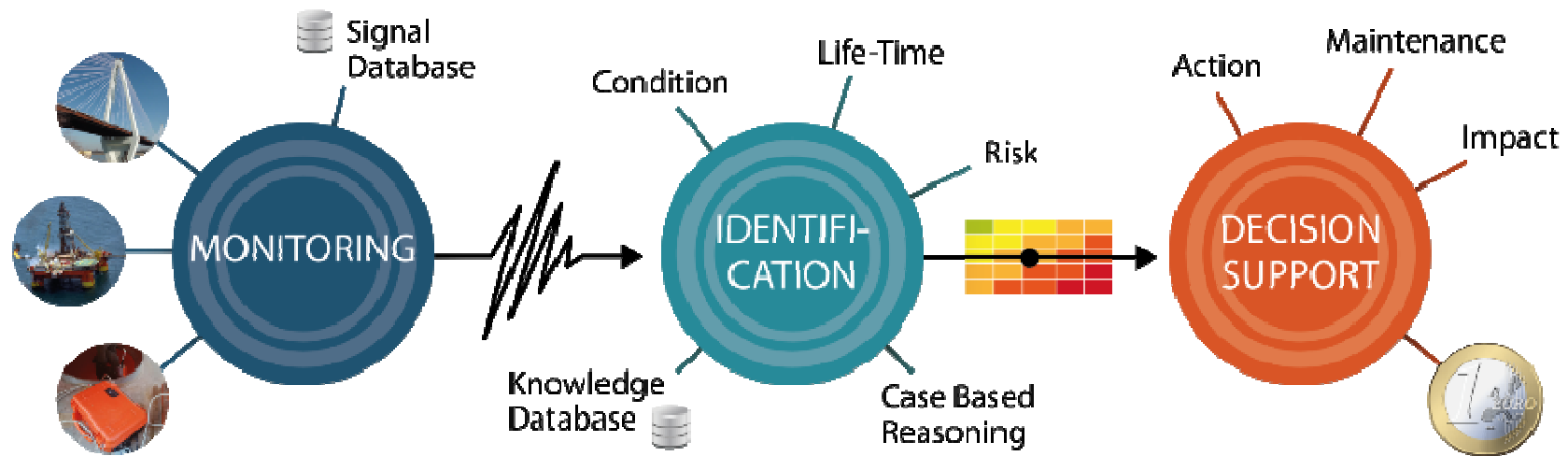


Structural Health Monitoring

Structural Health Management



1. Monitoring of the Structure
2. Identification of Condition
3. Decision on Safety and necessary Action



Performance, Risk and Safety

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Pier Condition after Ship Impact ?

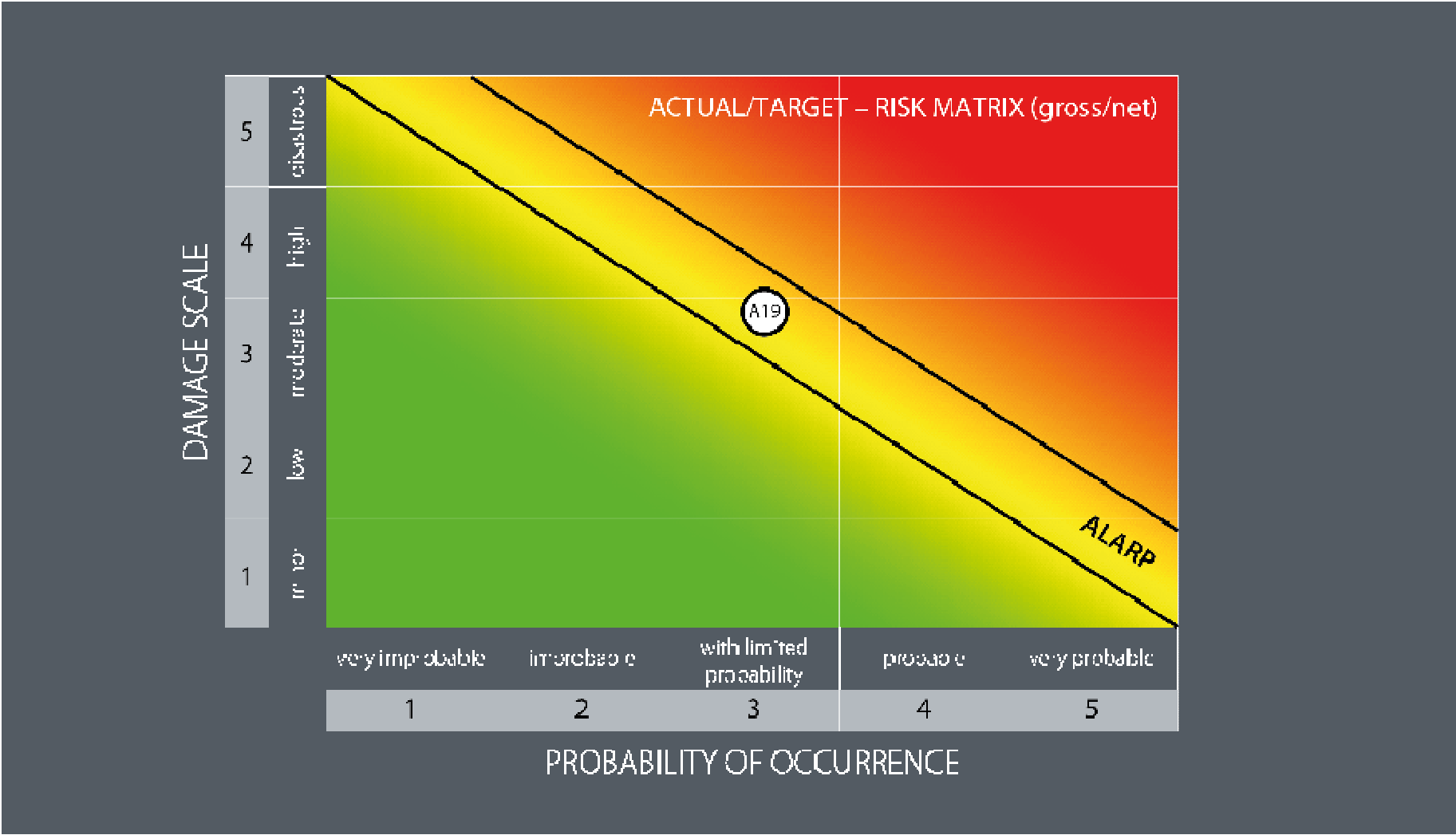
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Risk Assessment for Decision Making

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Risk Quantification (Probability of Occurrence / Damage Scale)



Collapse of Cần Thơ Bridge

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Corruption

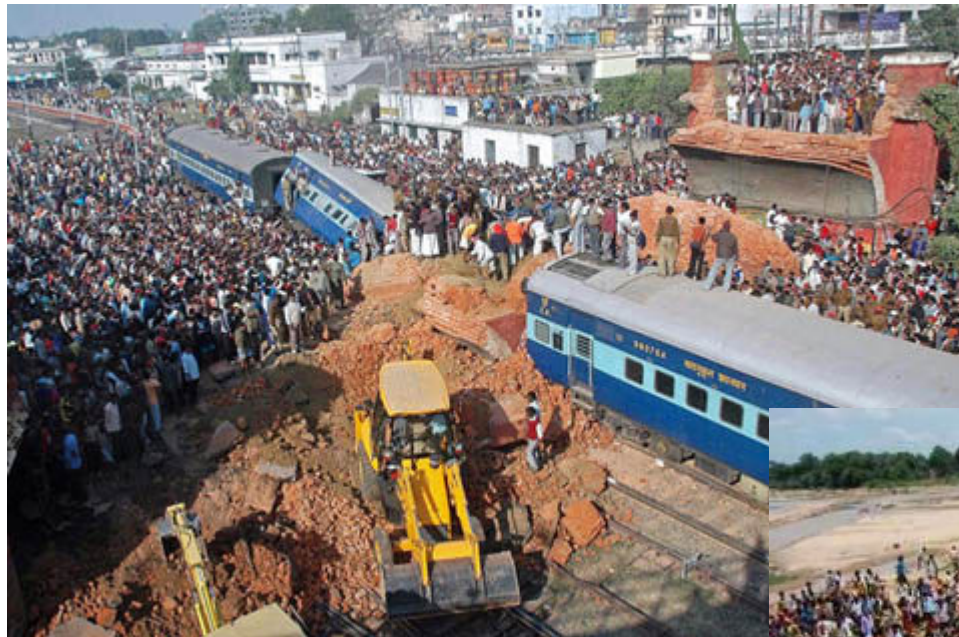


59 Casualties

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Misconceptions





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Understanding Technologies



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Understanding Interrelations





China

Scour

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Understanding Hazards



Mount Vernon, Washington

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Redundancies



Jiujiang Bridge, Beijing 2007

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Understanding Performance



Famous I-35 Collapse



Izmit Bay Bridge, Turkey

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Texas



Kobe

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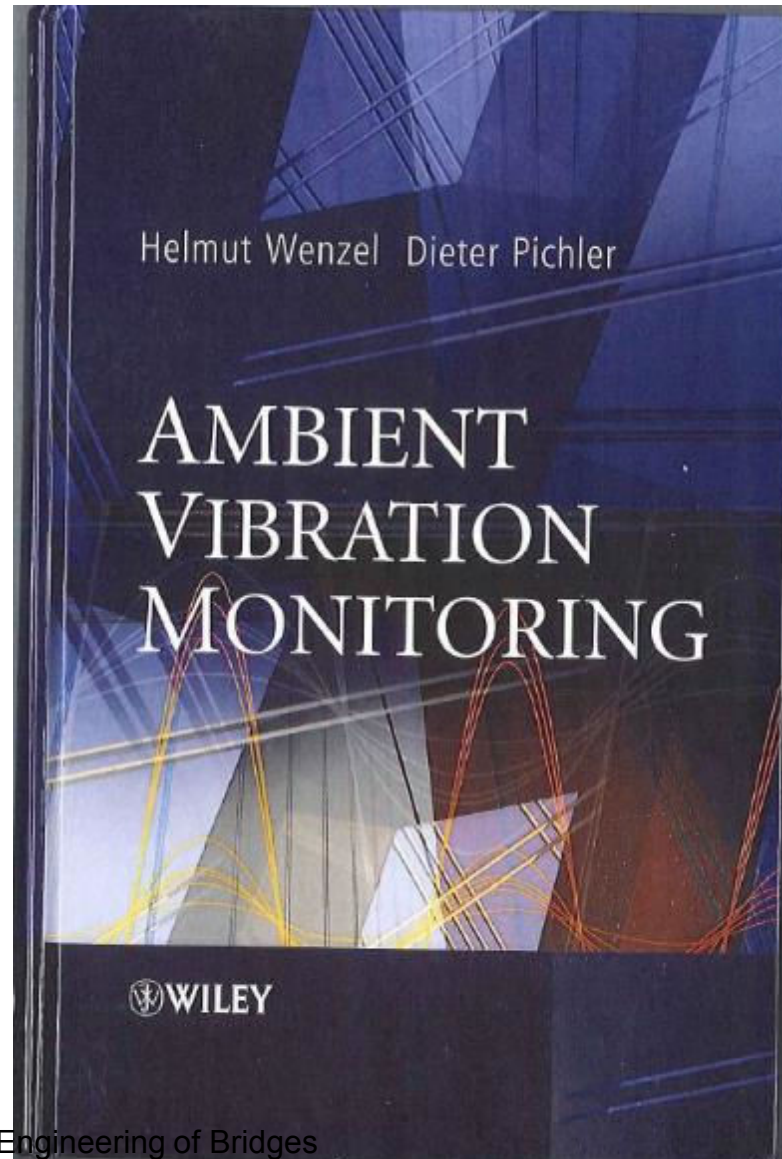
Natural Hazards



Best Practice Document (SAMCO 2005)



2. Edition in progress



Bridge Monitoring and Assessment (2009)

Available also in Chinese



责任编辑: 刘婷婷 董苏华
封面设计: 科地亚盟



“本书陈述了教科书中很少提及的一种技术, 对于桥梁管理者、使用者和设计者来说都不是那么容易掌握, 同时也给学术界提供了宝贵的信息资源, 在领会该技术的基础之上教会学生。本书作者是本领域的知名学者和权威人士。”

——詹姆斯·布朗约翰, 英国设菲尔德大学结构动力学教授

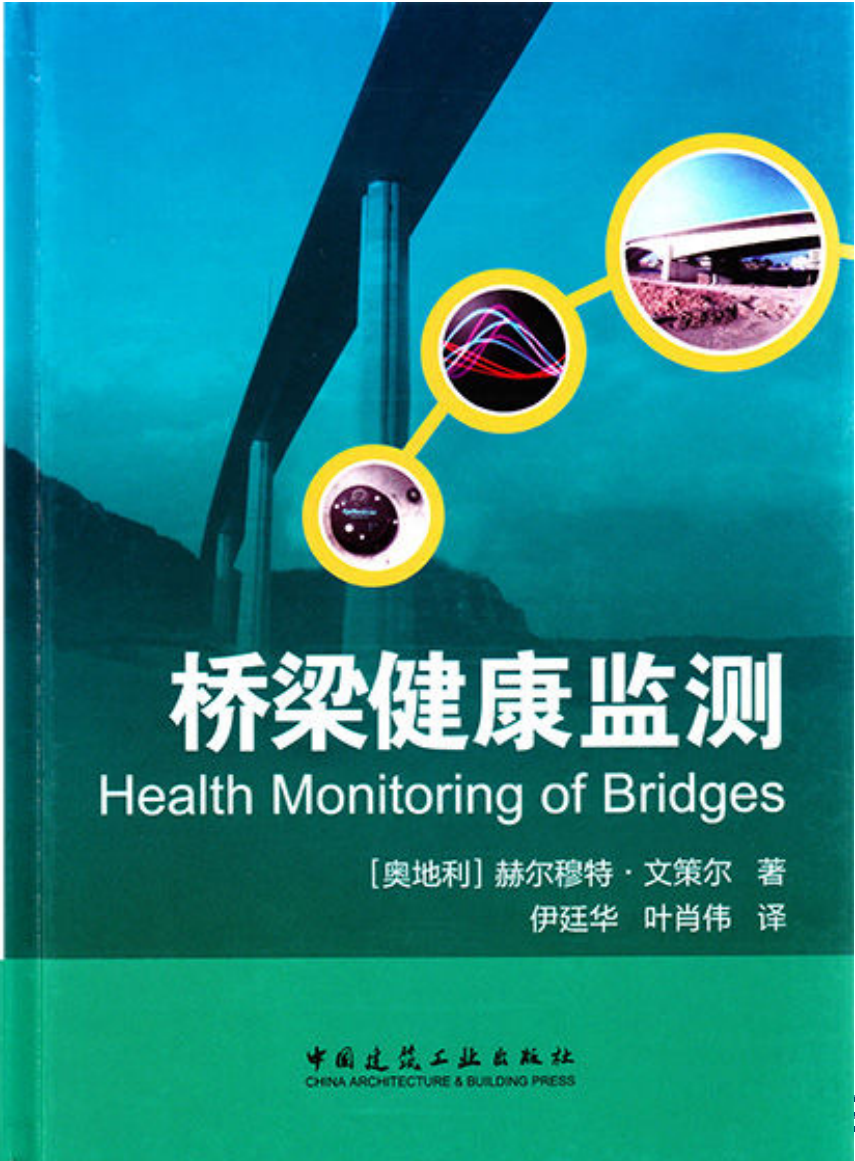
《桥梁健康监测》一书介绍了桥梁工程领域取得的重大新技术进展, 借鉴了航空及其他工业部门获得的研究成果, 并对最新的桥梁管理方法进行了讨论。

- 章节内容涵盖了健康监测中使用的硬件、方法论、各种方法的应用 (材料、方法、系统和功能)、决策支持系统、损伤识别系统, 以及桥梁评级和风险评估方法。
- 包括被动和主动监测方法。
- 提供了可直接应用的方法以及各种实例、应用和参考。
- 由健康监测系统发展的世界领导者撰写。
- 包含免费软件 (下载网址: www.wiley.co/go/wenzel), 提供基准项目的原始数据和重要结果。

本书在桥梁结构健康监测的各个方面为工程师提供了全面指导, 涵盖概念设计至维护的所有阶段, 可供土木工程和结构健康监测领域的学者和研究人员参考。



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桥梁健康监测


Health Monitoring of Bridges

[奥地利] 赫尔穆特·文策尔 著
伊廷华 叶肖伟 译

中国建筑工业出版社
CHINA ARCHITECTURE & BUILDING PRESS

SHM Standardization Activities in Europe (IRIS 2012) SHM Manager®

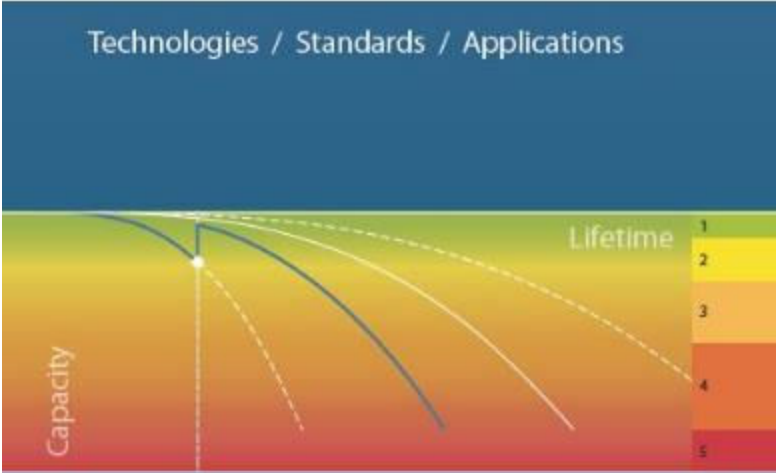
Free Copies available!



Helmut Wenzel
Coordinator

Industrial Safety and Life Cycle Engineering

Technologies / Standards / Applications



The graph plots Capacity (y-axis) against Lifetime (x-axis). It features five curves representing different engineering scenarios. A vertical dashed line marks a specific lifetime point. A color-coded legend on the right side of the graph is numbered 1 to 5, corresponding to the curves.

Example: New Structures

Tai Zhou, China



3. Bosphorus Bridge Monitoring

European Side



3. Bosphorus Bridge Monitoring



Halifax – Joint Performance

Two Suspension Bridges



Typical Monitoring Cabinet

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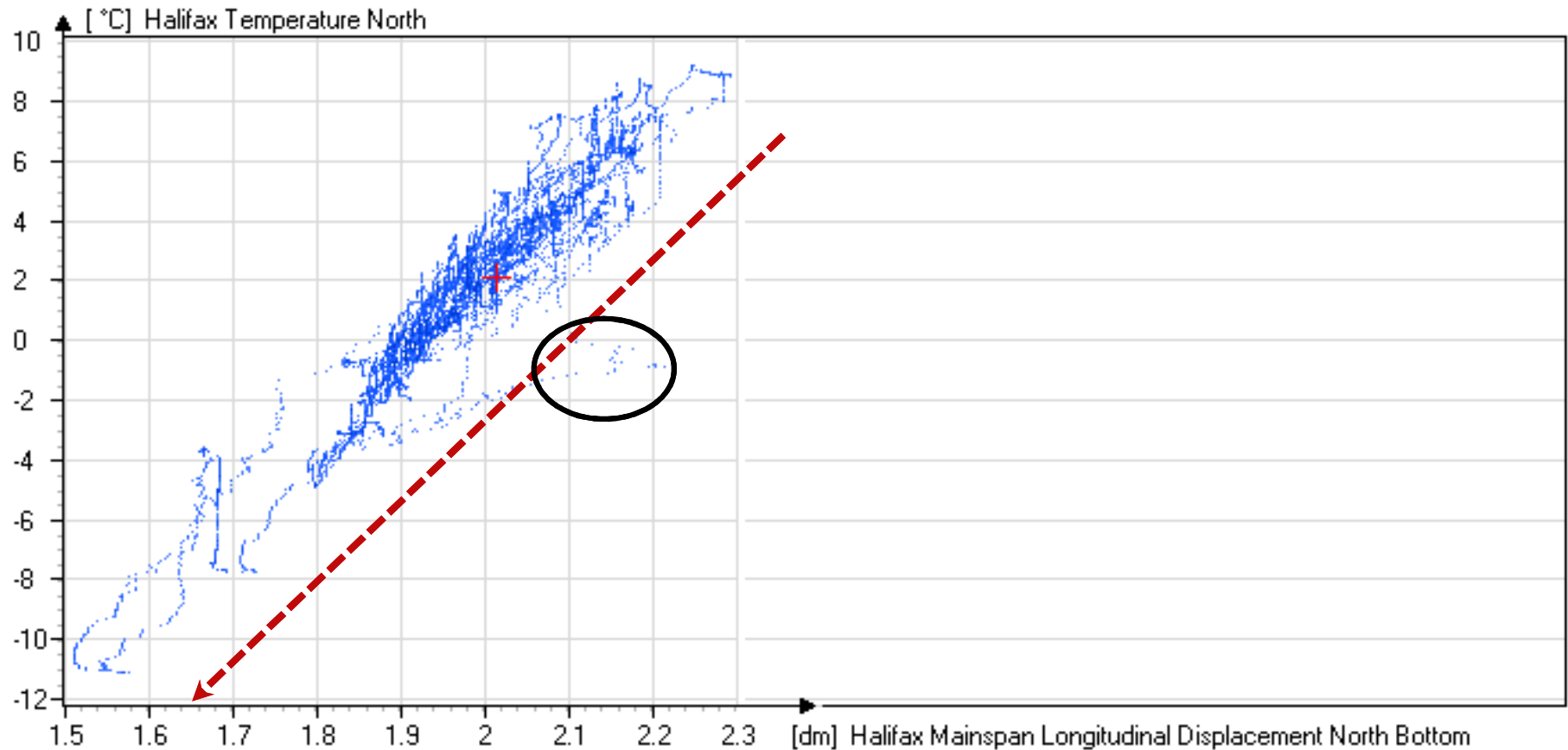


Un-typical Monitoring Conditions



Alarm from outliers in correlation functions SHManager®

Correlation Temperature - Displacement:

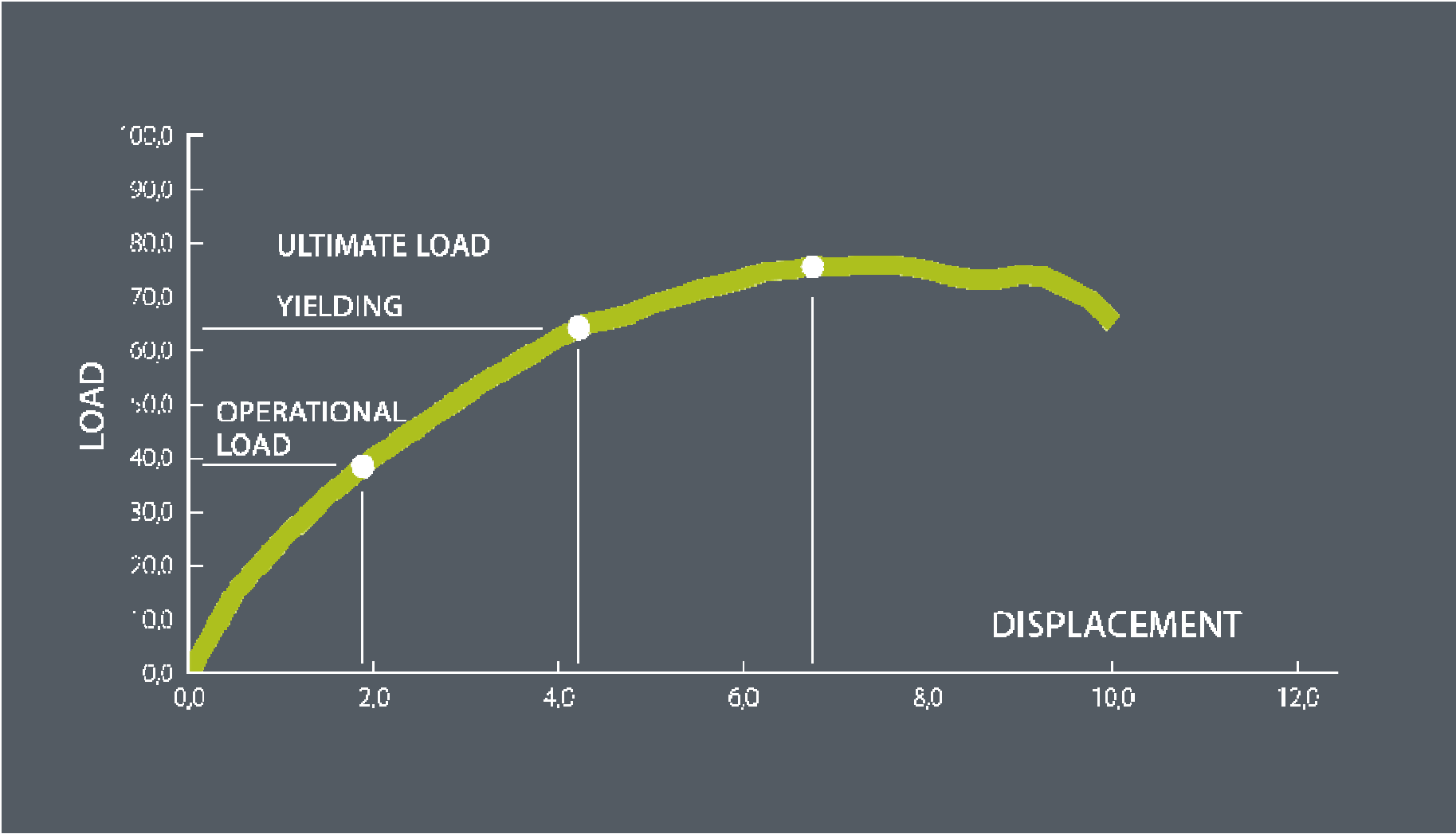


Identification Objectives

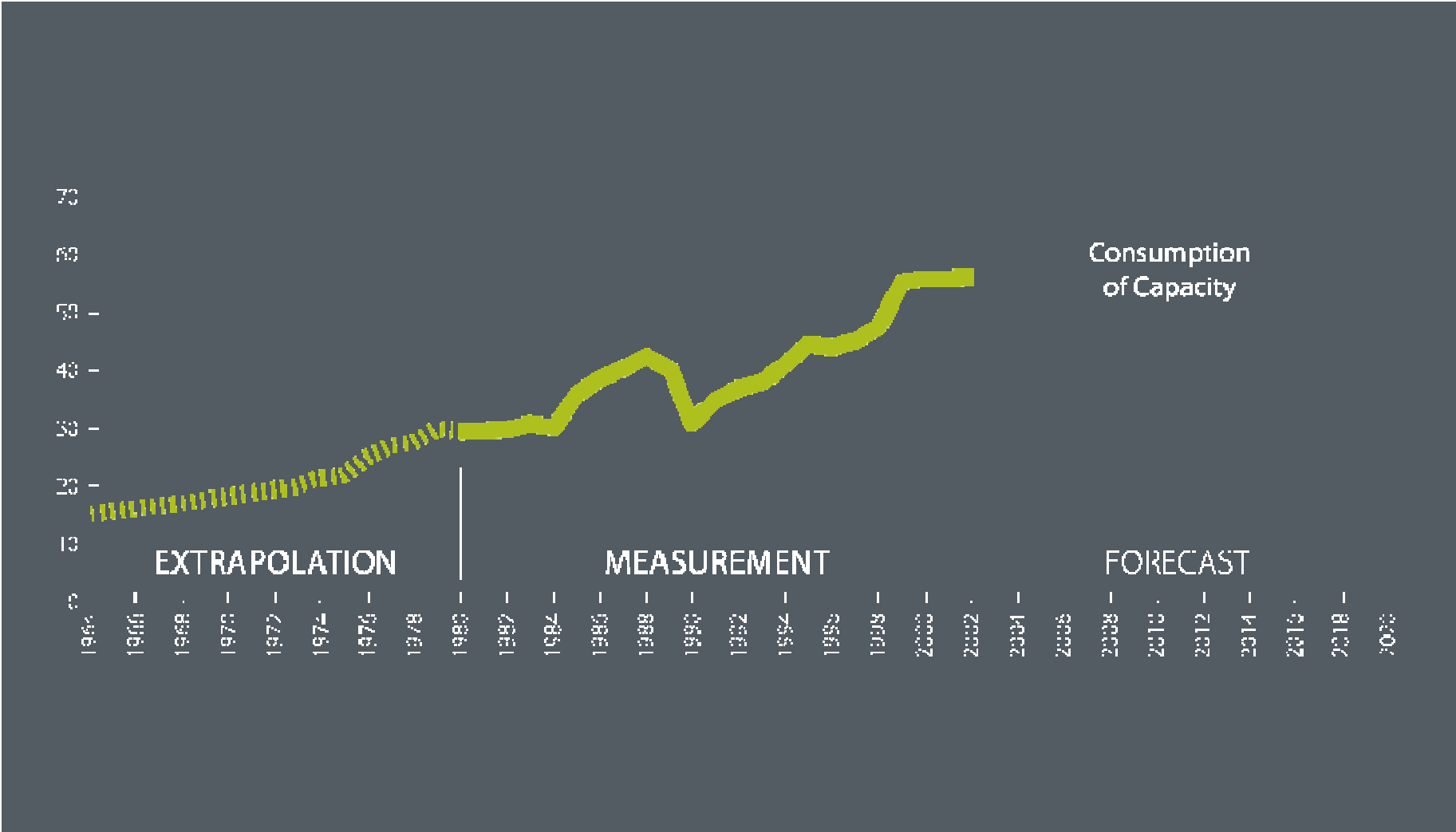


1. Ultimate Load
2. Fatigue Life Determination
3. Targeted Inspection Programme
4. Quantification of Life Extension

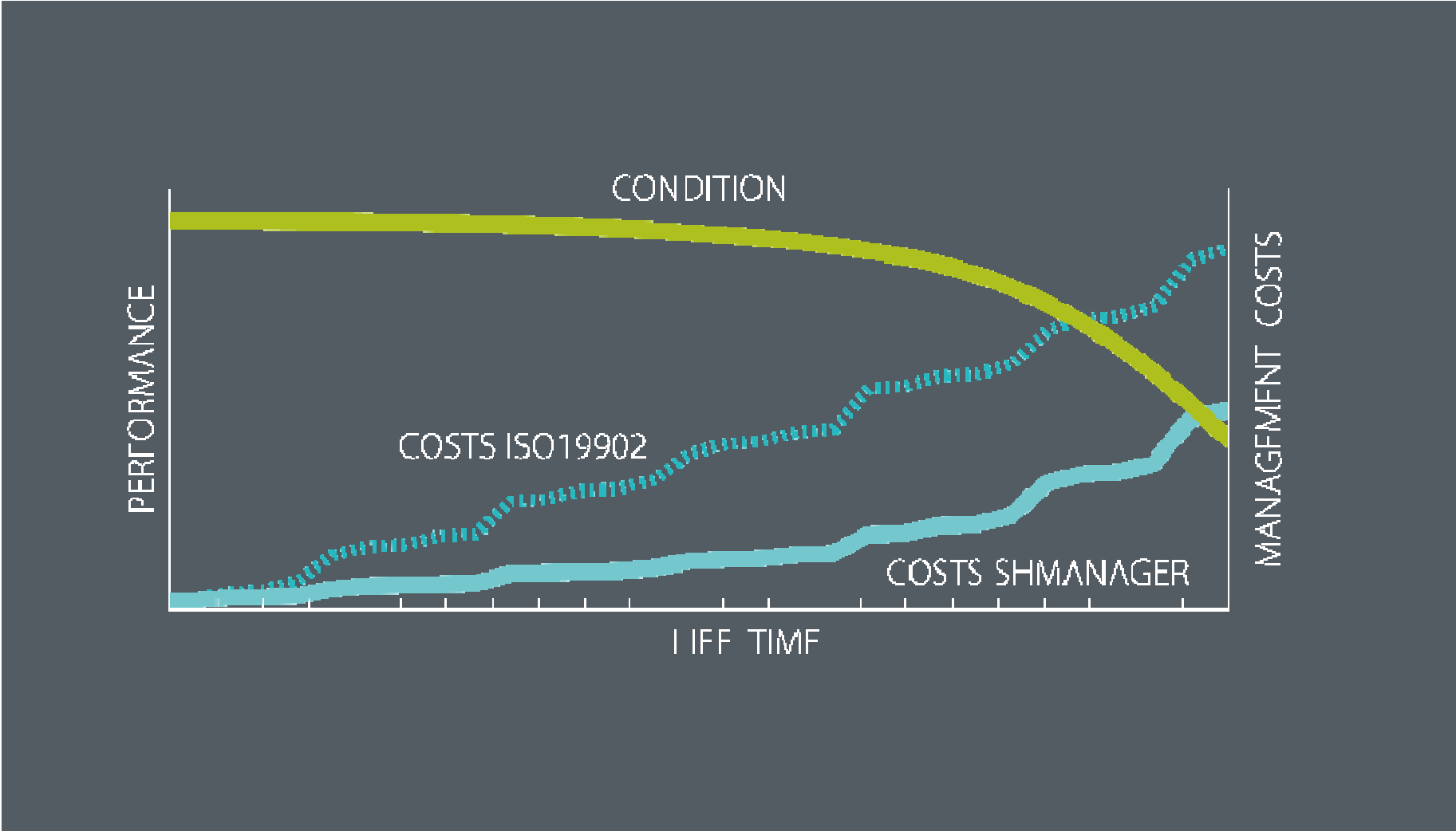
Ultimate Load



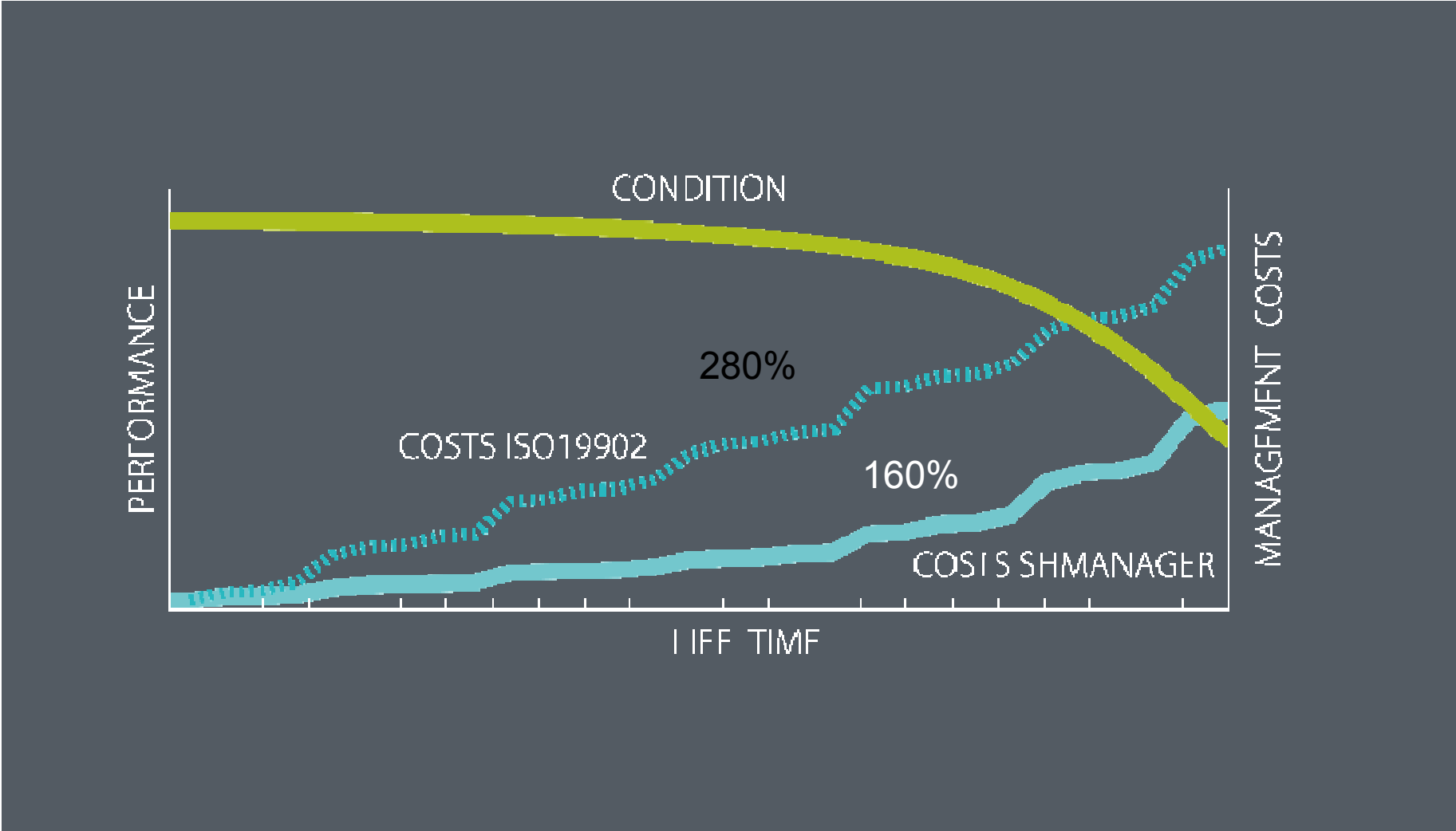
Fatigue Status



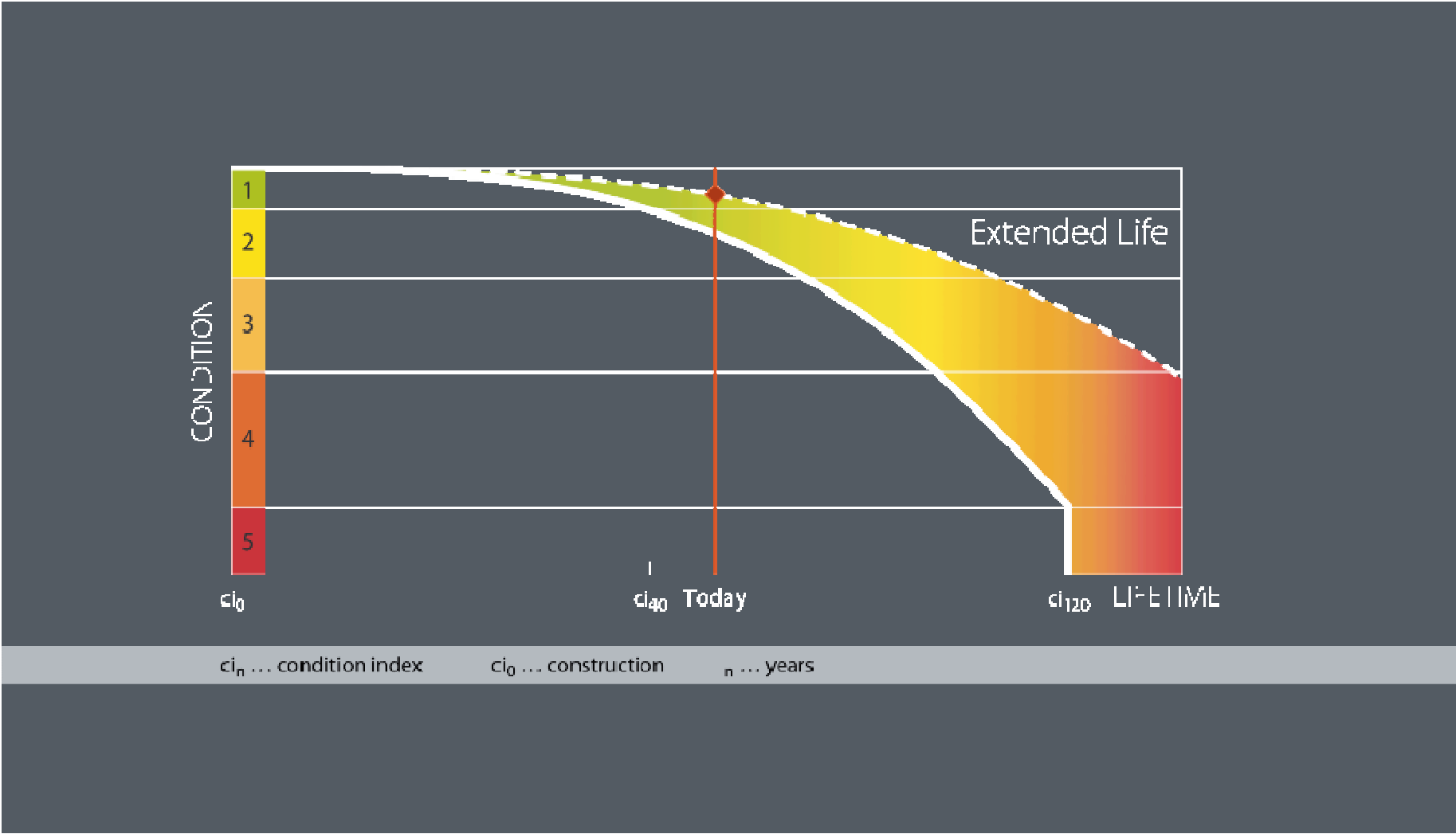
Targeted Inspection



Targeted Inspection



Extension of Life

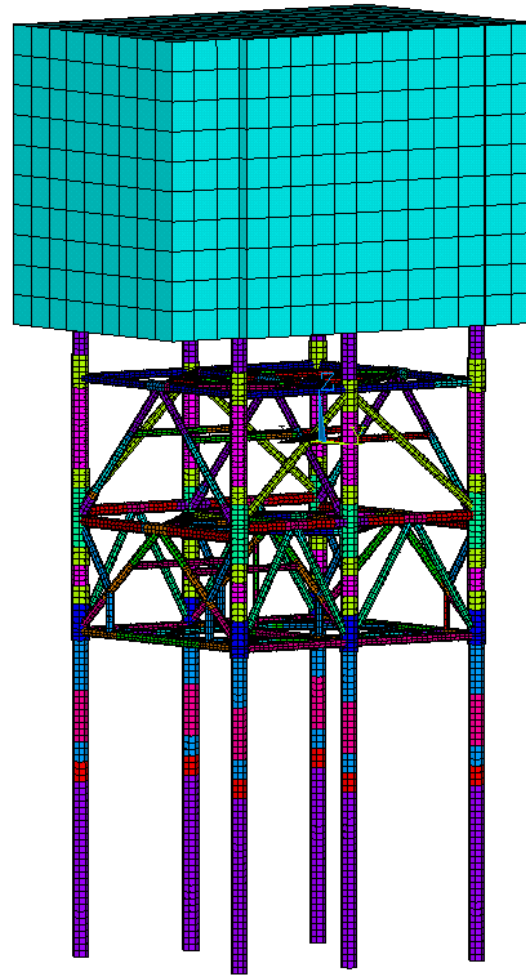


Ultimate Load

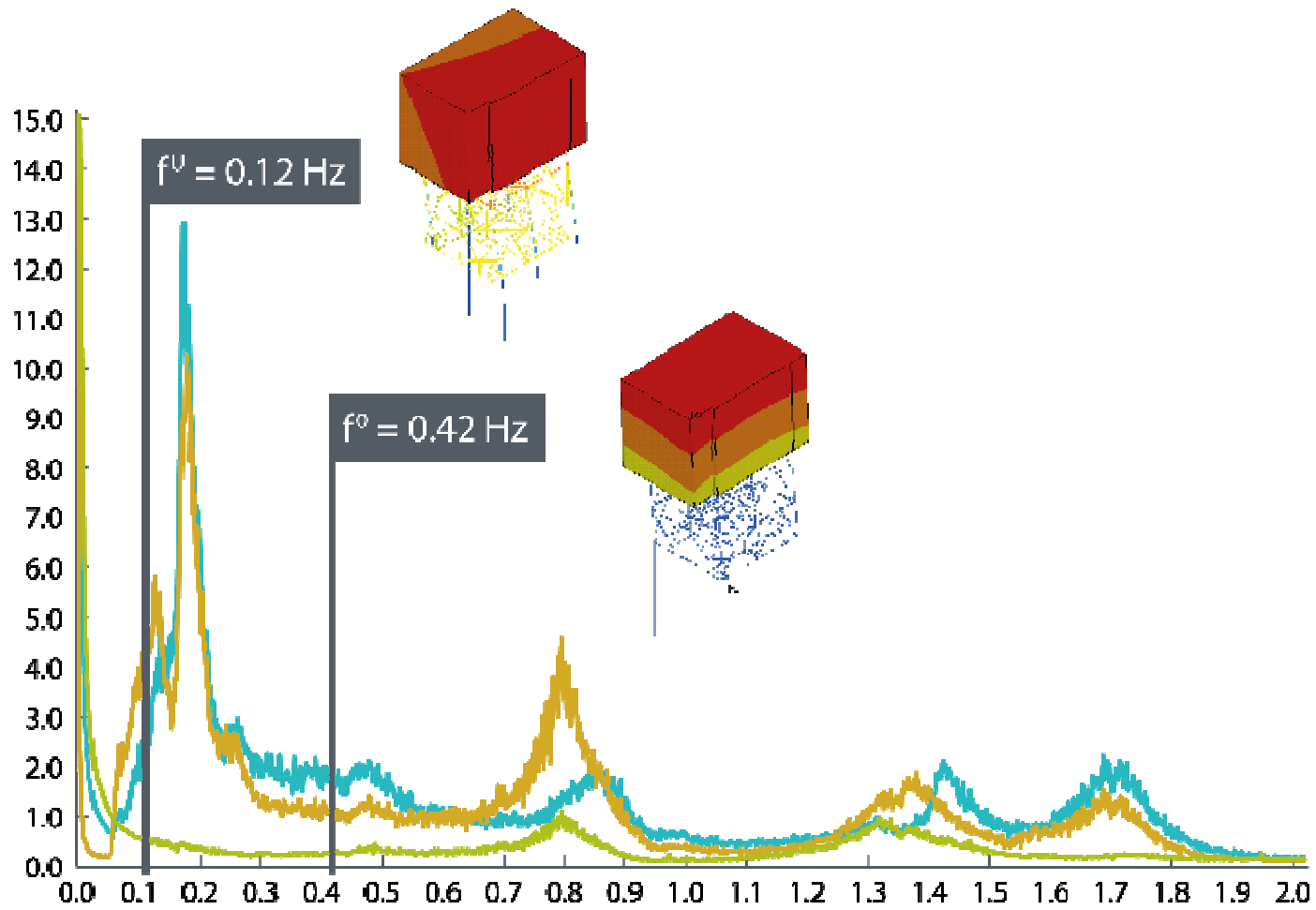
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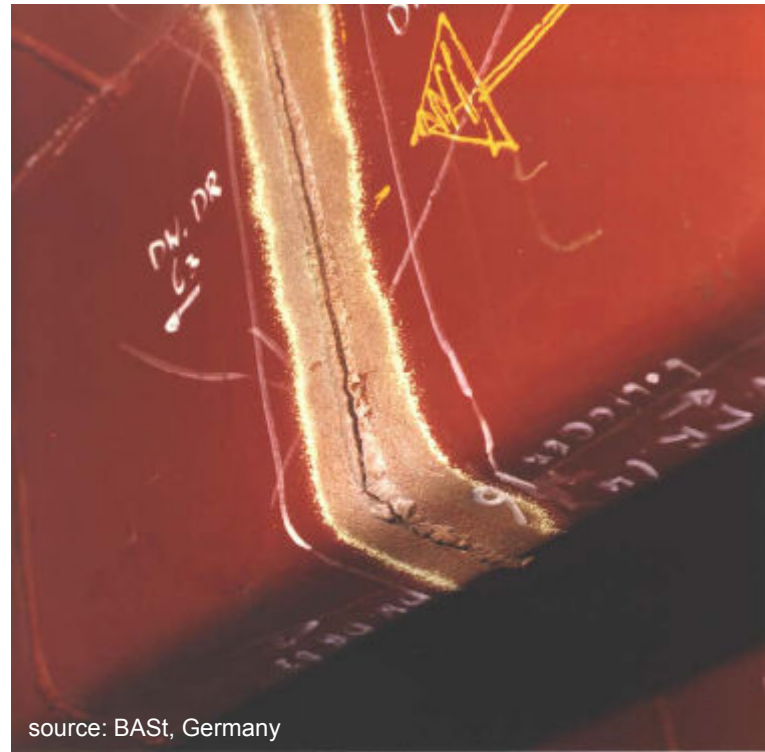
Ultimate Load Modelling



Ultimate Load Update



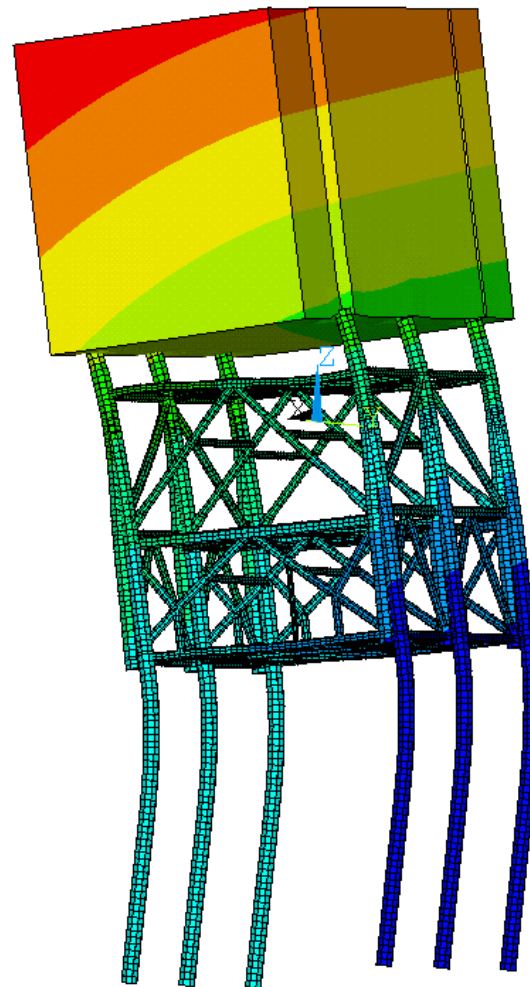
Fatigue Deterioration of Welded Steel Structures



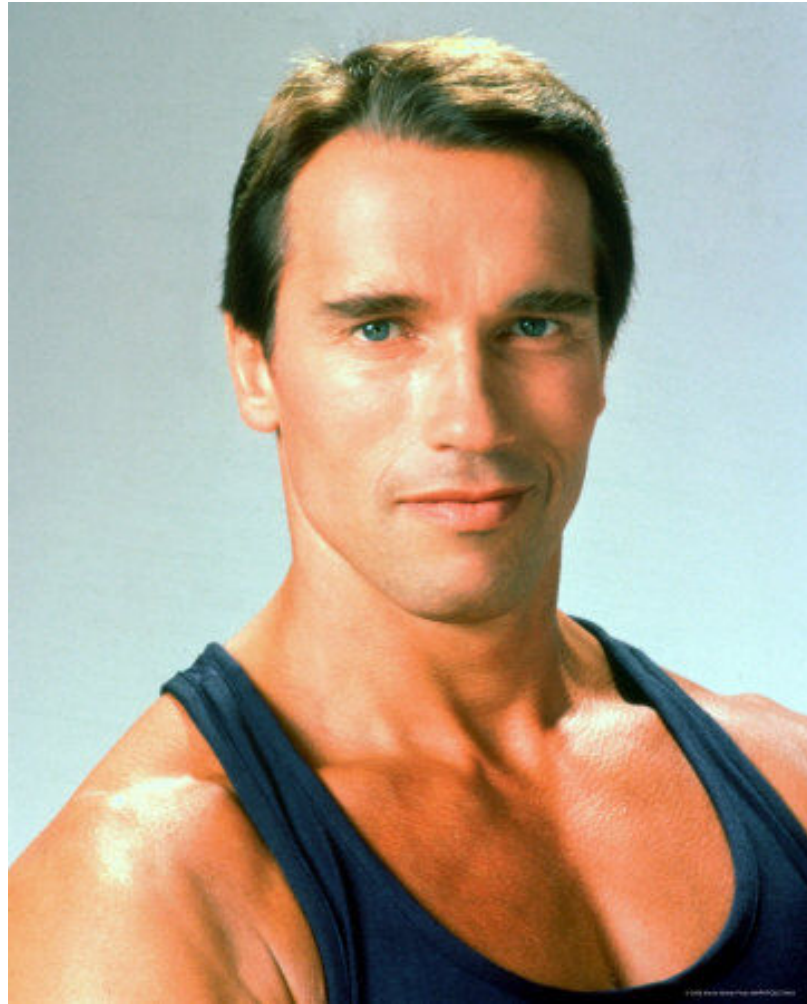
These crack show up in the dynamic response of the structure!

Ultimate Load

Failure Mode



Aging



Date: 2014-01
CEN/TC 319
Secretariat: UNI

Risk-Based Inspection Framework

Document type: European Standard
Document subtype:
Document stage: CEN Enquiry
Document language: E

Offshore Wind Industry

Different Asset Management Concepts

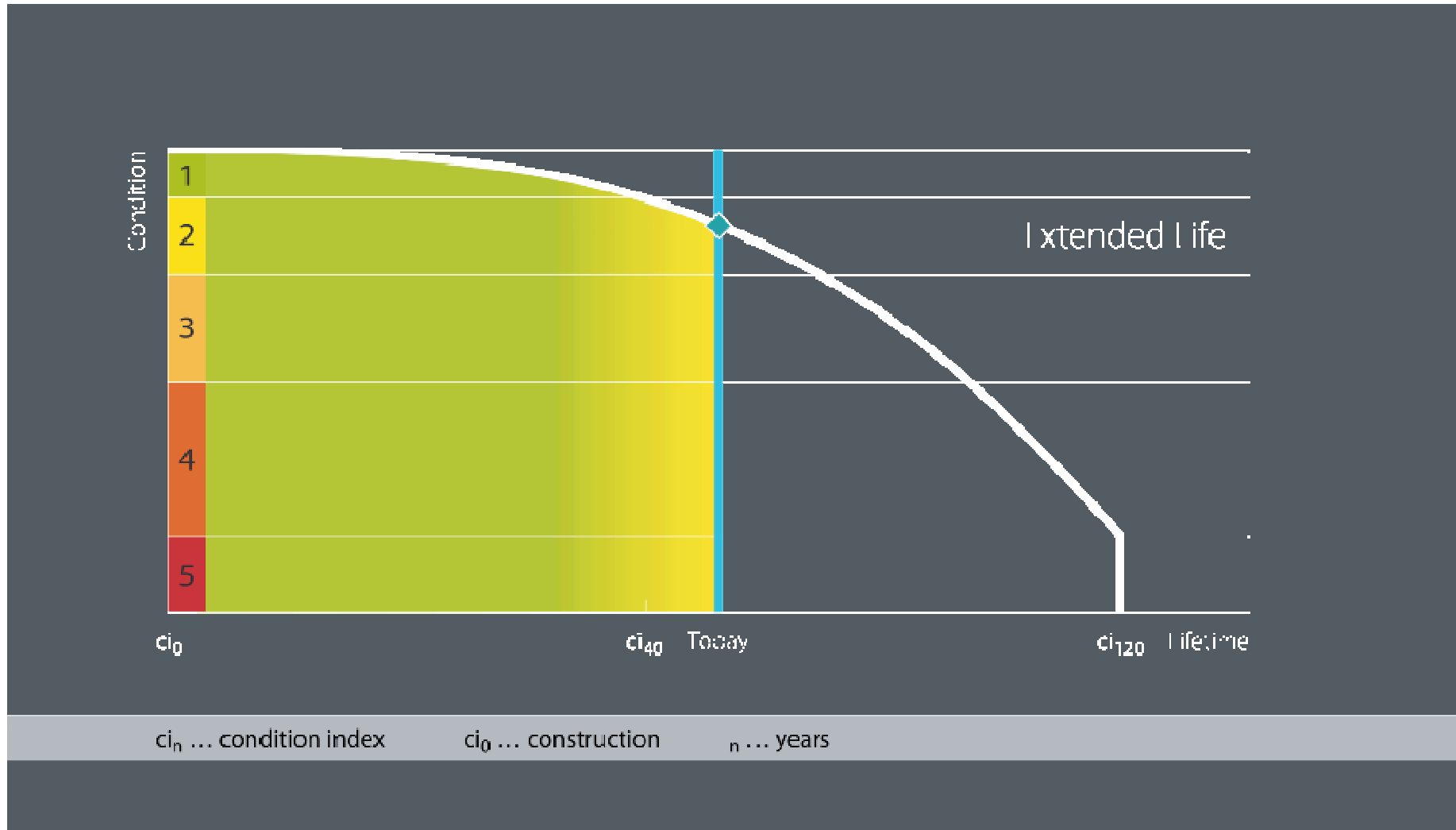
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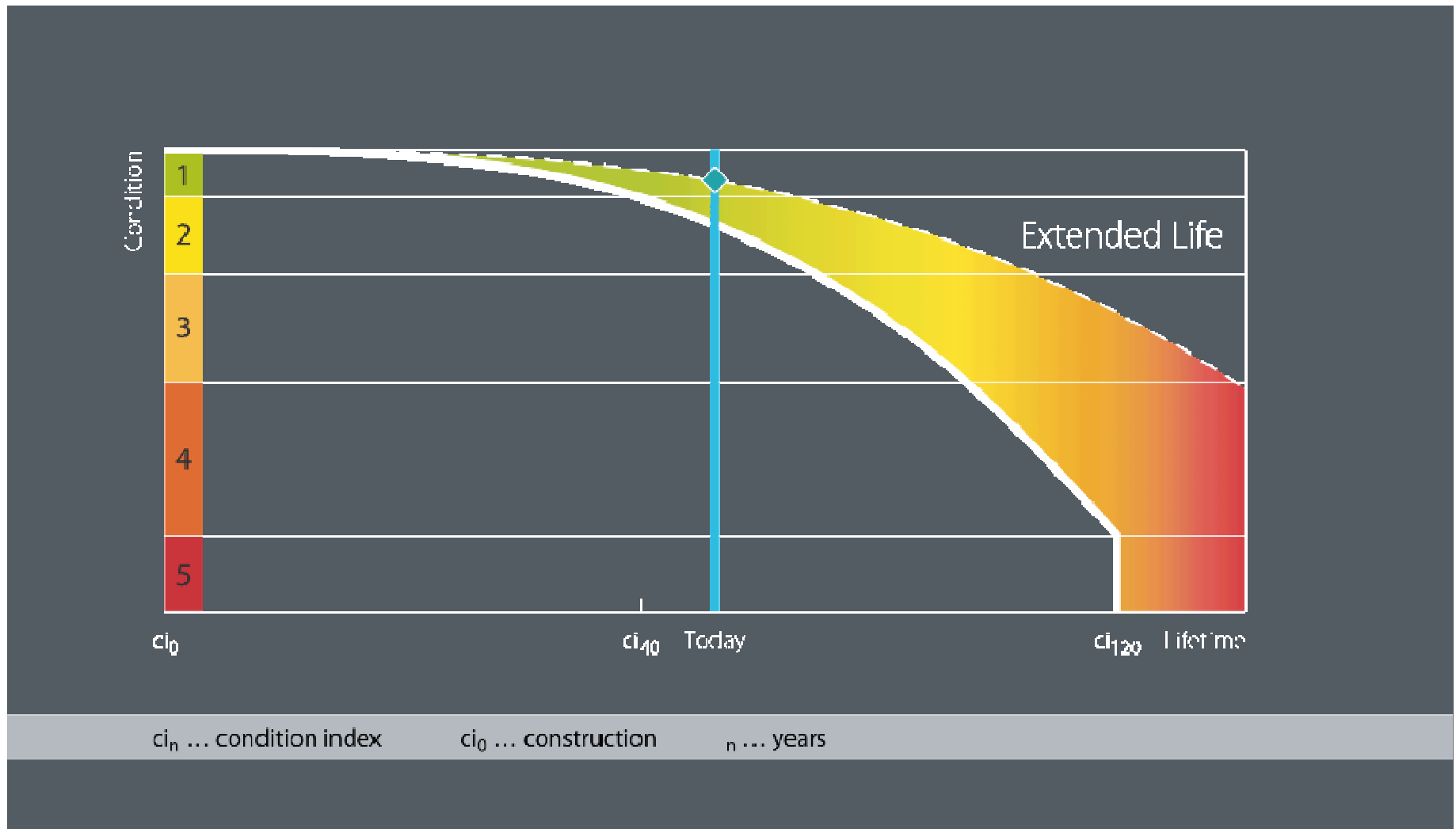
Quantification of Life Extension

Extension of Life Potential



Quantification of Life Extension

Extension of Life Potential

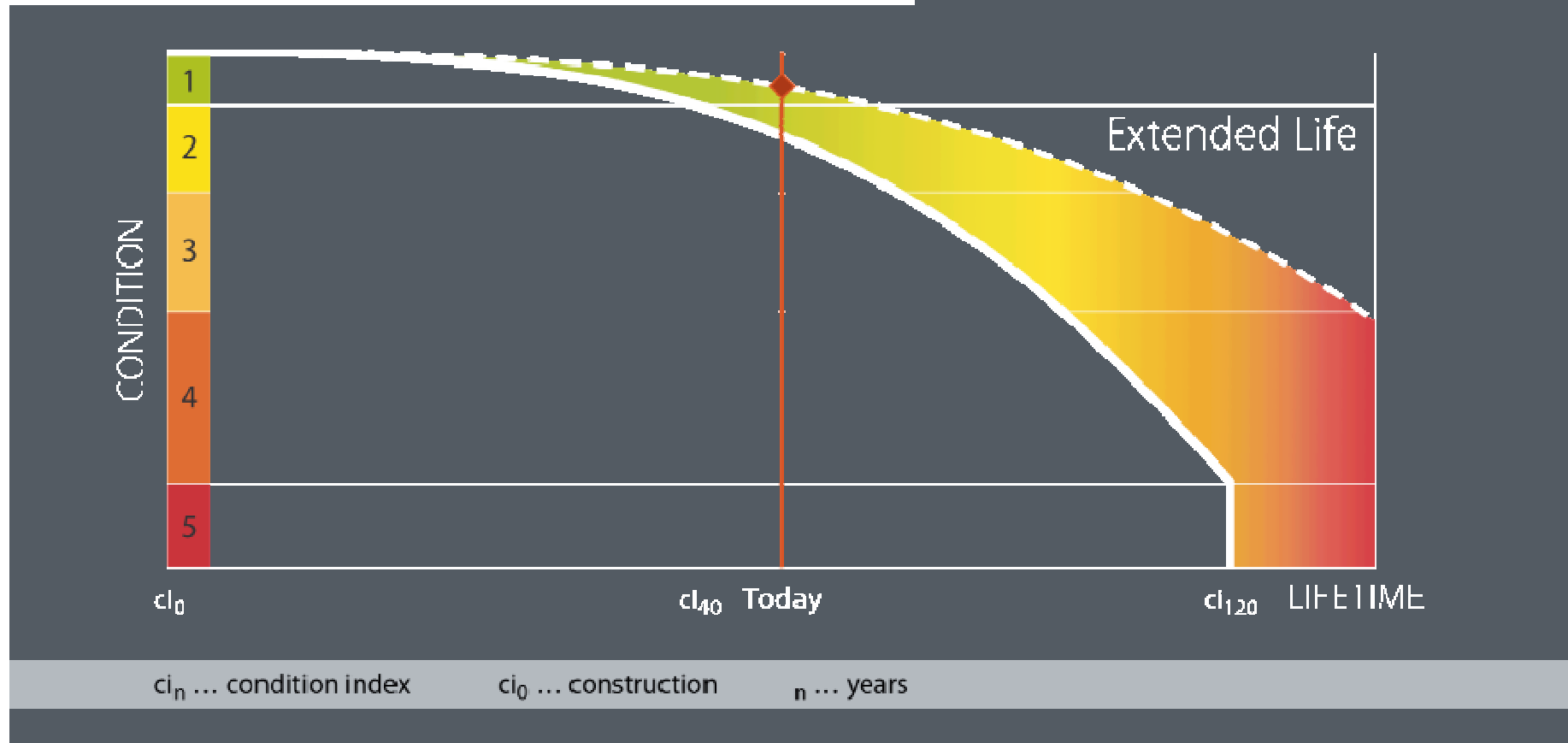


Quantification of Life Extension

Extension of Life Potential



► Potential Life Extension: 16 Years ◀



Decision Support

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- Accurate Condition rating and performance assessment is feasible using Monitoring Info
- Asset Management is supported
- Costs are reduced without sacrificing safety
- Inspection programs are individually designed
- Extension of life time is quantified and justified

Thank You !

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