ICSAT 2013

The usage of lightweight materials in hazardous areas –
Flex-Metal-Mesh

Institut für Technik und Design GmbH

First question

What are hazardous areas?

1 Introduction – hazardous areas

Fig.1 Examples of hazardous areas

Second Question

What is Flex-Metal-Mesh and what's its potential at all?

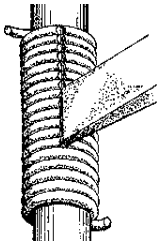
2 Basic material – Flex-Metal-Mesh (Past)

Who Invented by Celts
used by Romans
used in the Middle Ages

When Approx. 3rd century B.C.

Why Armaments industry

How



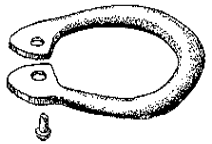


Fig.2 Manufacturing process in the past

2 Basic material – Flex-Metal-Mesh (Present)

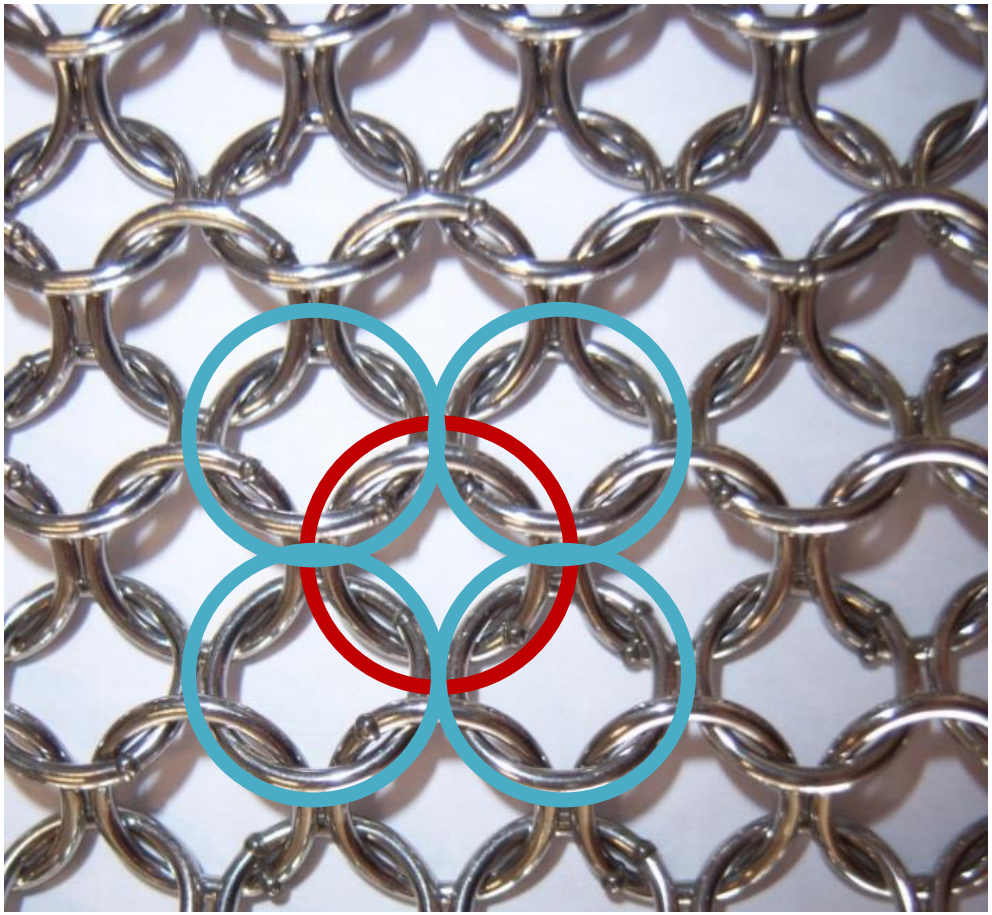


Fig.3 Flex-Metal-Mesh - chainmesh

2 Basic material – Flex-Metal-Mesh

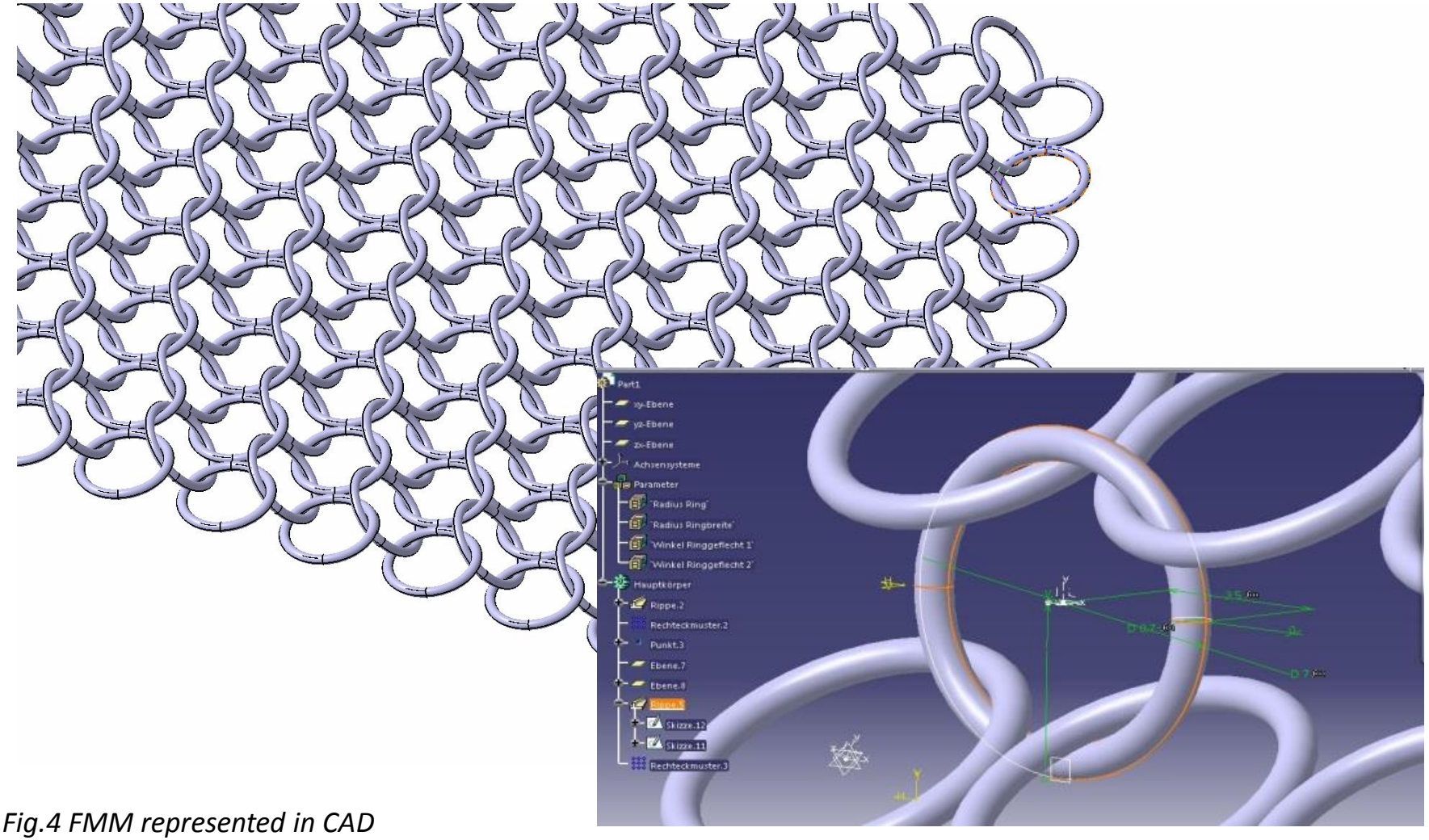
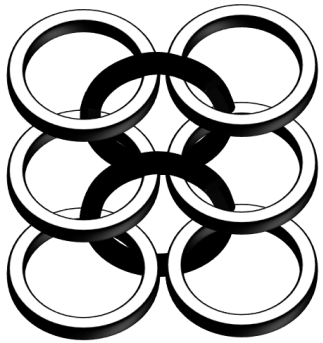


Fig.4 FMM represented in CAD

2 Basic material – technical parameter

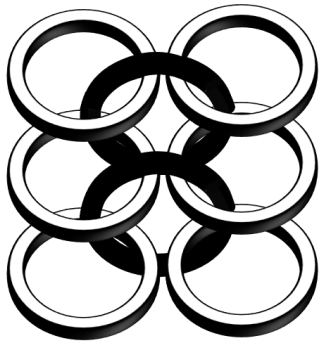
- Outer diameter d_A = 3,6 - 12,0 mm; wire gauge t = 0,4 - 1,3 mm
- Lightweight design: Mass per square meter G = 2210 - 4650 g/m²
- Materials:
  - Titanium
  - Copper
  - Stainless steel
  - …
- Material- und parameter dependent strength
- Serial production, industrial manufacturing
- Metallic and non-metallic bulk commodity
- Flexible and conform to various shapes



2 Basic material – interest

- ***Interested in***
  - Energy absorption of the mesh
  - Speed reduction
  - Path of movement
  - Risk of injury

- ***Usage of***
  - RG12x1.3 mm
  - 4 in 1
  - Wire material
    - 1.4404
    - X 2 CrNiMo17-12-2
    - Elongation min. 35%
    - Normalized



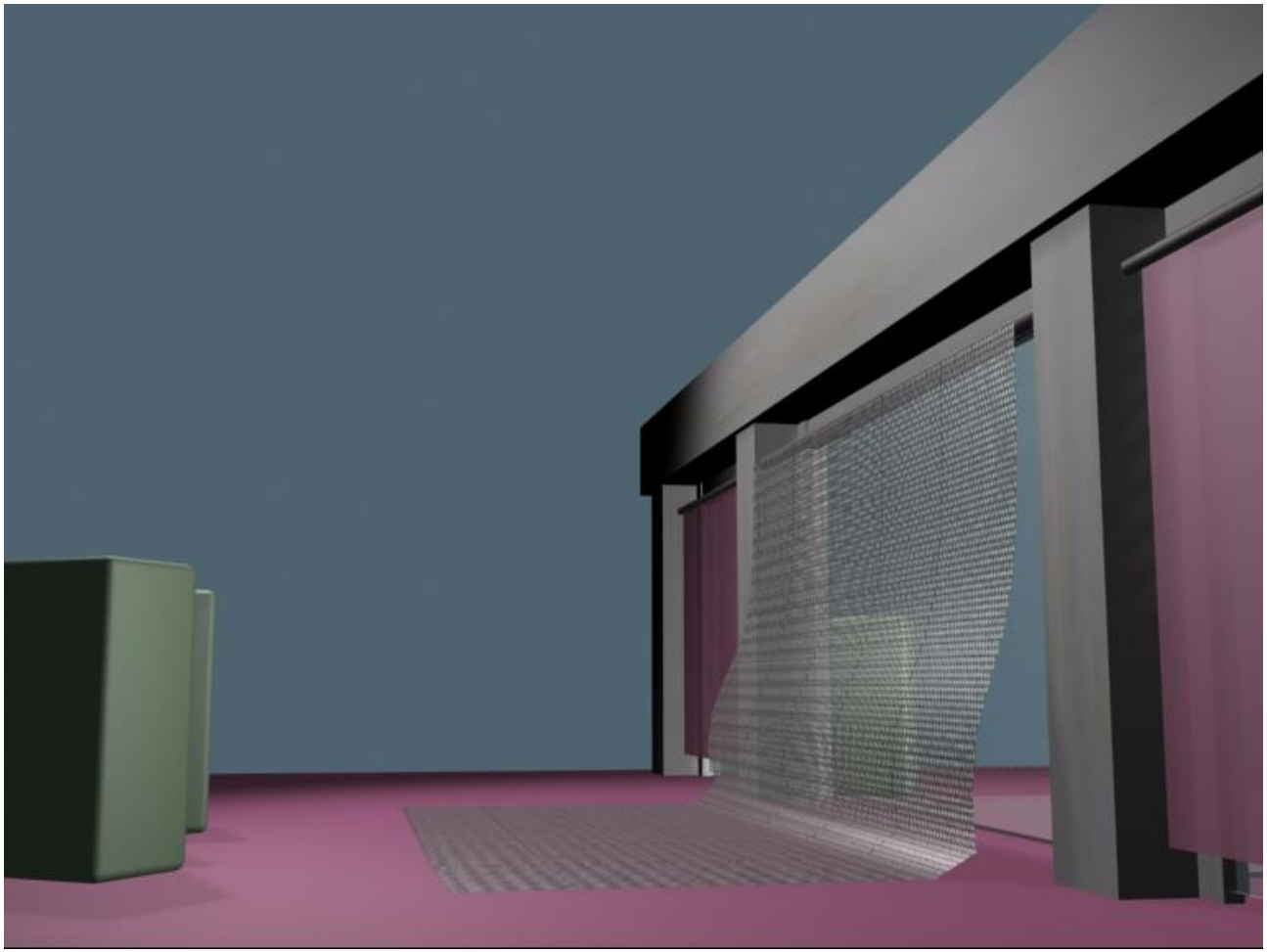
Third Question

How can the hanging version of the Flex-Metal-Mesh be represented regarding a load impact due to customer understanding?

3 Basic idea – experimental test

Test-No3.mpg

3 Basic idea – animation



3 Basic idea – application range

Fig.5 Experimental surroundings

Fig.6 Test bed

Fig.7 Fence at ski slope

4 Basic research – tensile test

- Considerations/expectations
  - Increase of tensile force with increasing number of rings
  - Increase of tensile force dependent on the width/height of the mesh
  - No change in the tensile stress at different mesh arrangement
  - Weld seam as weak point of the structure
  - Determination of crack location (center of the mesh/fixation)

- Test preparations

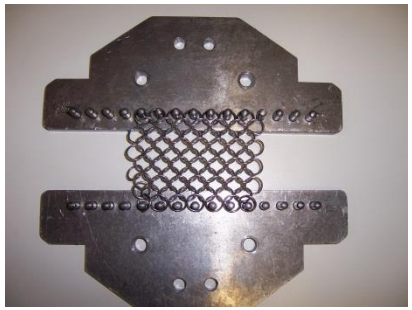
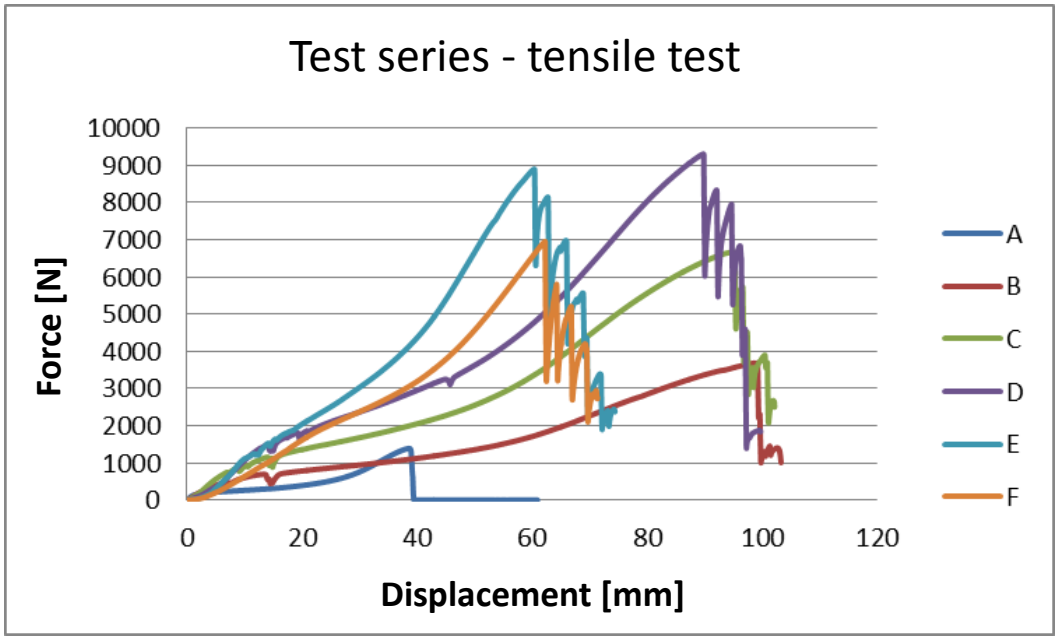


Fig.8 Test samples regarding the tensile test and test equipment

4 Basic research – tensile test

Universal testing machine Zwick Z010/TN2A - 10kN

- Pre-load F_P = 1N and Pre-velocity v_P = 10 mm/min
- Test velocity v_T = 100 mm/min



Series	Parameter	Amount of rings	Force F [N]
A	1 x 7	7	1356
B	3 x 7	42	3663
C	5 x 7	70	6544
D	7 x 7	98	9014
E	7 x 5	70	8827
F	7 x 7	98	7391

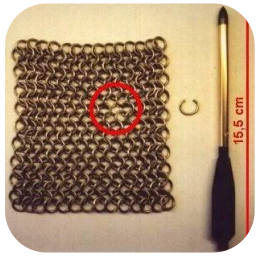
5 Application range

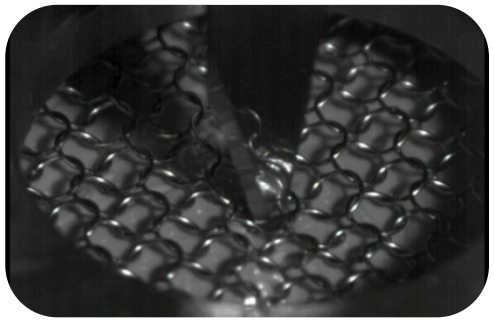
- Safety fence
  - Impact body: Human being
  - Impact energy: E_{Kin} = 31 kJ
  - Outdoor application

- Vehicle barrier
  - Impact body: Vehicle
  - Impact energy: E_{Kin} = 13 kJ
  - Outdoor application

Fig.9 Various test configurations

6 Theoretical approach - pointed impact





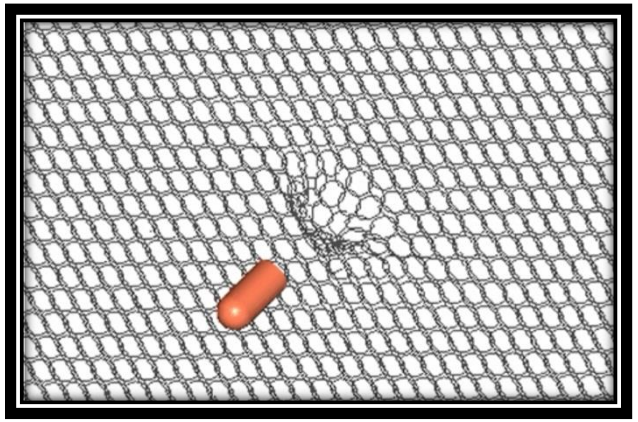


Fig.11 Simulation of pointed impact

6 Theoretical approach - planar impact

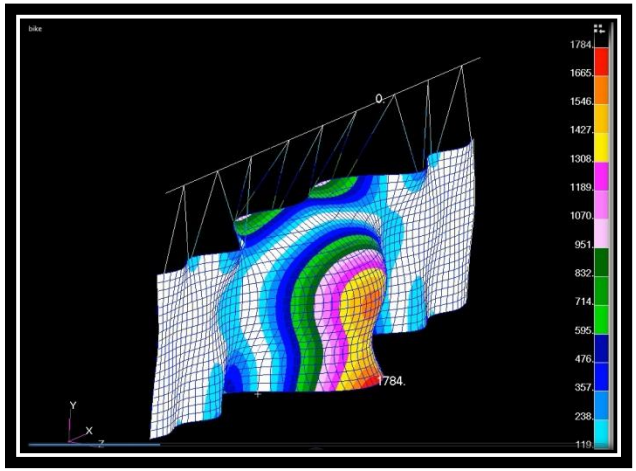


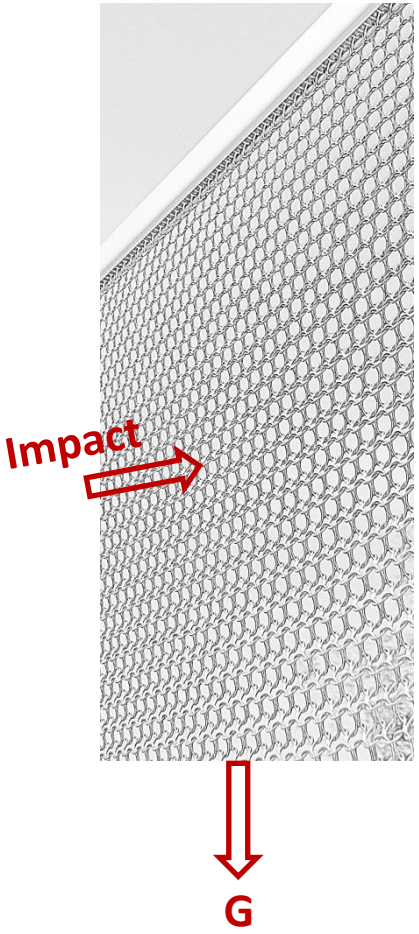
Fig.10 Simulation of planar impact

Third Question

How can the hanging version of the Flex-Metal-Mesh be represented regarding a load impact due to customer understanding?

6 Theoretical assumptions

- ***Assumptions***
  - large deformation
  - small distortions
  - Large-scale impactor
  - slow reaction time



  - Due to the high per cent by weight of the impactor any slipping or sliding of the individual elements is neglected
  - Plastic deformation of the individual elements are not intended

6 Theoretical approaches

- Membrane theory
  - Formless and flexible structure
  - Applicable only under pre-stress
  - Absorption of tensile forces

- Cantenary curve
  - Curve function due to the dead weight or distributed load
  - Analytic approach

- Smoothed Particle Hydrodynamics
  - Mesh-free Lagrangian method
  - Simulation of fluid flows

7 Summary of application range

Provides effective protection against impact, bombardment, blast and shock, penetration, puncture, collision, stab and stitch injury:

- blast protection
- security fence, barrier
- building and facilities enclosures
- personal security
- rearmament of military and civilian facilities
- protective clothing
- transport systems
- architecture, design element

Safety of humans and increase of survivability !

8 Conclusion

Key points

- properly engineered manufacturing process
- industrial manufacturing
- easy product access - serial production

Properties

- metallic and non-metallic bulk commodity
- flexible and conforms to various shapes
- perfectly suited for retrofitting buildings and surroundings
- transparency
- wide application range both indoors and outdoors
- weather resistance
- can be used on land, on water and in the air

Flexible protection system - effective, invisible, decorative and unique !

Contact details

Dipl.-Ing. (FH) Eva Wilhelm

eva.wilhelm@itd-in.de
0049 (0) 173 - 7742126

Prof. Dr.-Ing. Jörg Wellnitz

joerg.wellnitz@thi.de
0049 (0) 841 - 9348 - 221
0049 (0) 173 - 2068055