

OST
Ostschweizer
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Smart base plate design

Automating and optimizing structural engineering calculations

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Smart base plate design

Presenters



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Agenda

- Introduction
- Base plates & PROFIS Engineering (PE)
- Demo of typical customer flow when using PE
- Implemented automation and optimization
- Demo of smart design
- Conclusions and outlook

Smart base plate design

Base plates are everywhere in construction ...



Columns and beams



Façades



MEP



Handrails and signs

Smart base plate design

Engineers calculate these base plates using PROFIS



Structural engineers calculate buildings to resist loads, such as self-weight, usage, earthquakes, wind etc. acc. to their country construction norms and regulations.

The screenshot displays the Hilti PROFIS Engineering software interface. The central part shows a 3D model of a concrete base plate with four Hilti anchors (HUS4-H, HUS4-C, HUS4-A) and their dimensions. The interface includes a 'DESIGN SELECTION' sidebar, an 'ANCHORS' list, and a 'MESSAGE' section at the bottom.

Anchor	N [kN]	Vx [kN]	Vy [kN]
1	7.693	1.25	0
2	0.054	1.25	0
3	7.693	1.25	0
4	0.054	1.25	0

N°	Name	Type	Forces [kN]	Moments [kNm]	Utilization				
			Vx	Vy	N	Mx	My	Mz	Max
1	Combination 1		5	0	10	0	2	0	42%

Hilti PROFIS Engineering is a tool that helps engineers calculate Hilti anchors in steel to concrete connections and create jobsite specs.

Smart base plate design

Base plate structural analysis is still a manual process

- As Hilti, we want to make our products the preferred choice for engineers
- That also means that anchors in plates can be easily designed
- Engineers today still take a lot of time and effort to design plates

- **Let's see a demo of a typical PROFIS Engineering design!**

Can technology help to accelerate design?

Smart base plate design

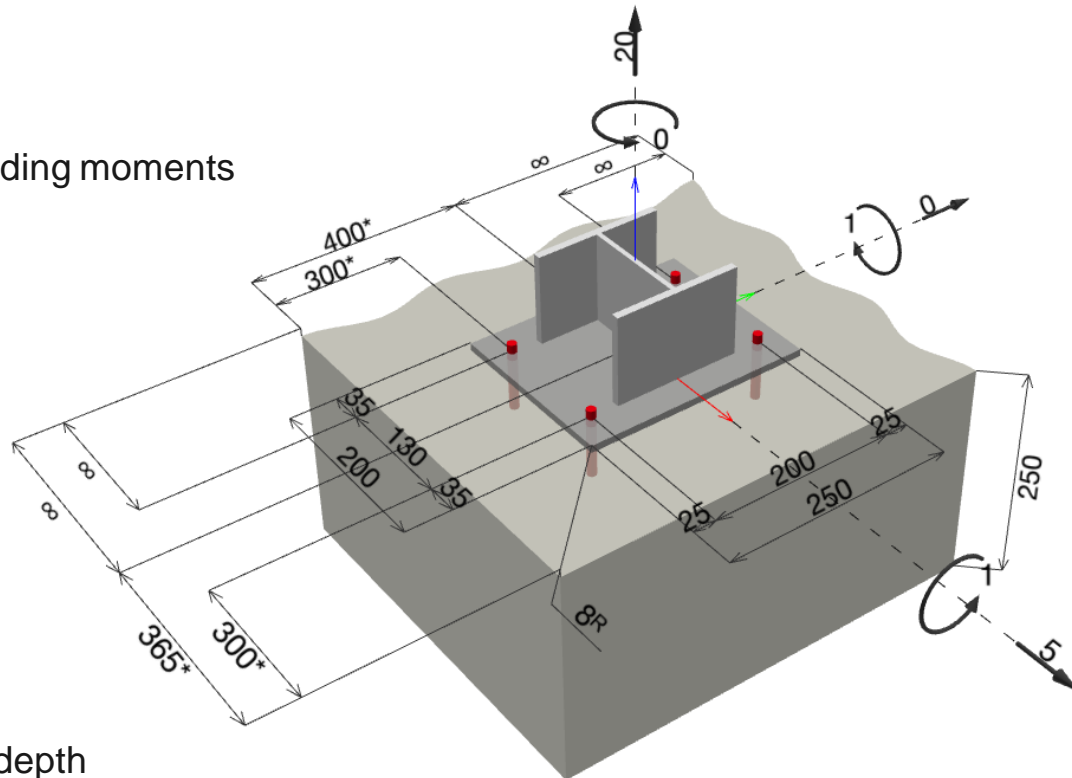
Problem

Parameters

- Concrete properties
- Profile used
- Acting forces and bending moments
- Selection of anchors
- (...)

Variables

- Fastener type
- Anchors layout
- Base plate size
- Anchors positioning
- Anchors embedment depth



Constraints

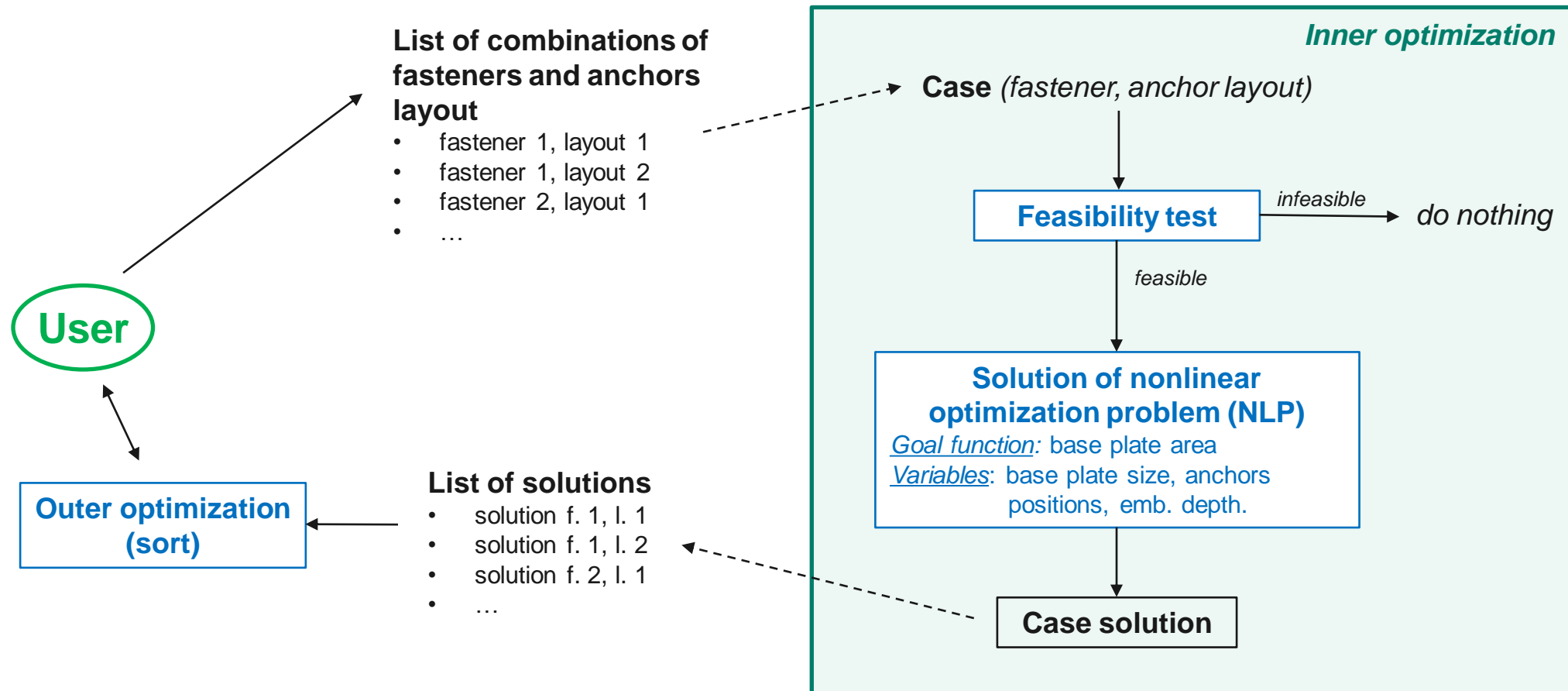
- Satisfying the norms for steel-concrete connections
- Minimum distances between anchors, concrete edges, profile
- (...)

Tension		
	Steel	29%
	Concrete breakout	85%
	Pullout	91%
	Splitting	0%

Shear		
	Steel	7%
	Concrete edge breakout	18%
	Pryout	6%

Combination		
	Steel	9%
	Concrete	90%

Implemented algorithm



Smart base plate design

Demo of smart base plate design

The screenshot displays the HILTI PROFIS ENGINEERING software interface. The top bar shows the HILTI logo, 'PROFIS ENGINEERING', and the project name 'Drafts_Concrete - May 29, 2024 (Drafts) - Germany, European design (EN, ETAG), EN1992-4 Mechanical, ETA-20/0867'. A search bar and 'ASK HILTI' button are also present.

The interface is divided into several sections:

- DESIGN SELECTION:** Includes 'Smart Design' (Beta, Manual, Auto) and 'Change to 2D'.
- APPLICATION BUILDER:** Lists categories like Highways, General Construction, Bridges, and Tunnels. Applications include Primary Columns, Primary Beams, Platforms and Mezzanines, and Stairs.
- MINIMUM REQUIREMENTS:** Shows 'PROFILE' and 'CONCRETE' tabs. The selected profile is 'IPBi/HEA' and the concrete is 'IPBi 100 / HE 100 A'.
- 3D Model:** A 3D view of a base plate on a concrete foundation with a coordinate system (X, Y, Z) and a 'Change to 2D' button.
- Search Results:** A list of 6 solutions found, all with 100% utilization. The solutions are:
 - HST4-R M16 | hef = 160 mm
 - HST4-R M16 | hef = 160 mm
 - HST4-R M16 | hef = 160 mm
 - HST4-R M12 | hef = 125 mm
 - HST4-R M12 | hef = 125 mm
 - HST4-R M12 | hef = 125 mm
- Table:** A table showing the design combination and forces/moments.

N°	Name	Type	Forces [kN]			Moments [kNm]			Utilization
			Vx	Vy	N	Mx	My	Mz	Max
1	Combination 1		0	0	60	0	0	0	

Buttons at the bottom include 'Advanced Input', 'Input custom factored loads', and 'Import factored loads from a spreadsheet'.

Smart base plate design

Conclusions and outlook

Successful collaboration between Hilti and OST, combining anchors & structural engineering knowledge of Hilti with the applied mathematics knowledge of the ICE institute.

Implemented an **efficient algorithm** for the design of steel-concrete connections that:

- strongly **reduces the design time** for structural engineers,
- typically **delivers better solutions** (lower cost, lower amount of material used) than the ones found manually.

Launch to customers & next steps

- The software is ready and tested per European and American construction guidelines
- Ongoing trial usage with limited customer pool
- The implemented smart design tool will be **activated for more than 10'000 users worldwide**
- **Follow-up Innosuisse funded project** to extend the project scope