Reinforced concrete design according to Eurocode

The Eurocode consists of a total of 10 general categories:
- EN 1990 (Basis of Structural Design),
- EN 1991 (Design Loads),
- EN 1997 (Geotechnical),
- EN 1998 (Seismic)

and material specific sections
- EN 1992 (Concrete),
- EN 1993 (Steel),
- EN 1994 (Steel-Concrete Composites),
- EN 1995 (Timber),
- EN 1996 (Masonry) and
- EN 1999 (Aluminium).

Design and construction of reinforced and prestressed concrete as per EN 1992:

1-1 General design requirements
1-2 Design for fire resistance
2 Concrete bridge Design
3 Reinforced concrete Silo and tank Design.

The following remarks to EN 1992 1-1. The pertinent national annex contains approximately 140 references to national definable parameters as well as further definitions, which bring the eurocode into compliance with the national safety requirements.
In 2007 the German national appendix was finished, with Friedrich + Lochner GmbH being a member of the pertinent committee.
At present design testing takes place in conjunction with German Concrete Society (DBV), Organisation of independent consulting engineers for building inspection (BVPI) and Association of Consulting Engineers (VBI) as part of an ongoing pilot project, with the participation of engineering offices and software companies including Friedrich + Lochner GmbH. The compulsory application of the eurocodes in Germany is expected to happen in 2010.

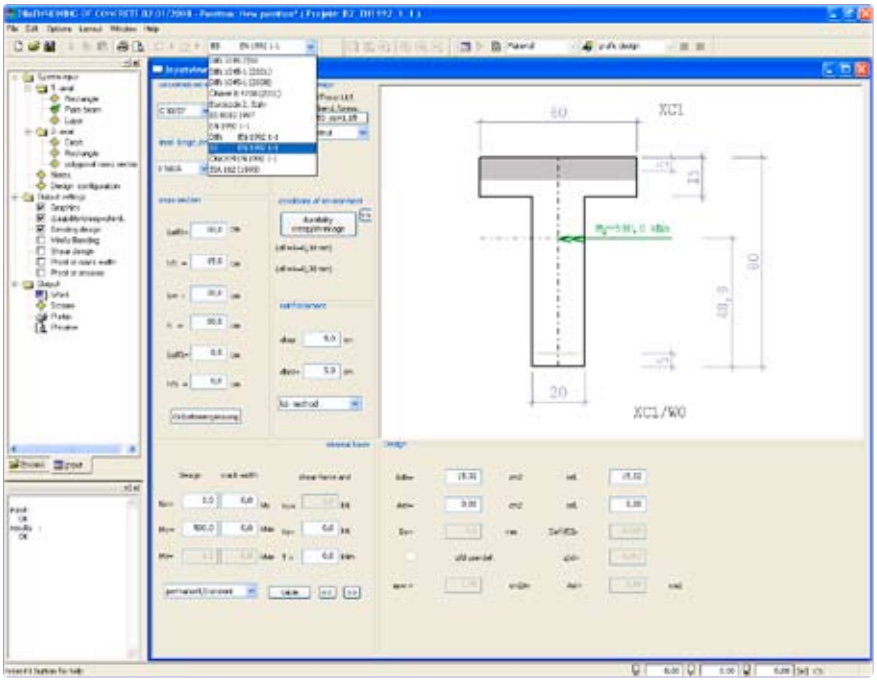


Fig.1 Bending design according to BS EN 1992 1-1 with the reinforced concrete program

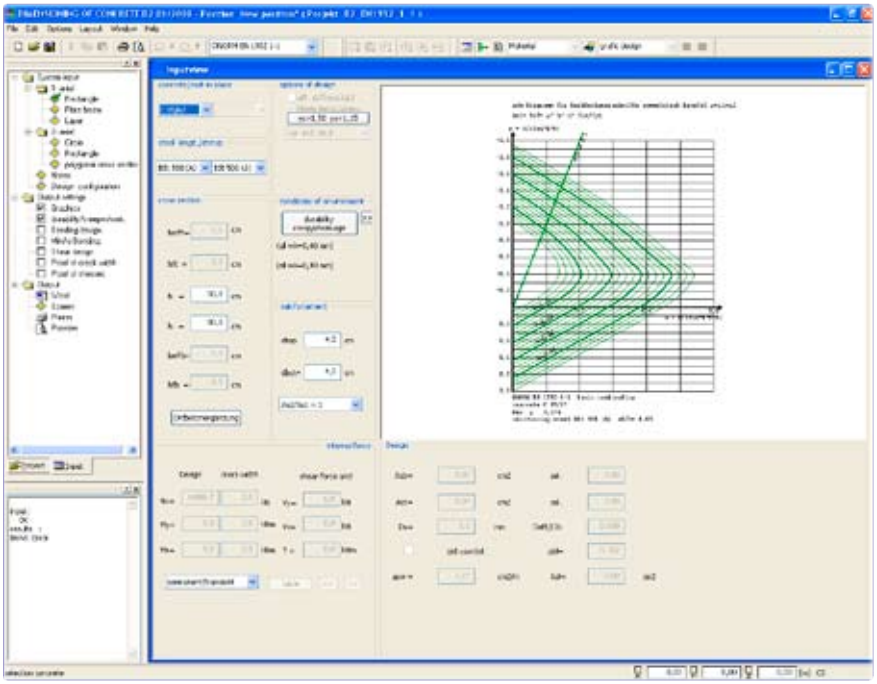


Fig 2 The reinforced concrete program provides Design Values for ÖNORM EN 1992

This corresponds to the latest possible date specified in guidance paper L of the European Commission.
In other countries the application of the Eurocodes is at a substantially more advanced stage with Great Britain already started in 2007, and with Austria and Denmark due to commence in 2008.

The eurocode appears increasingly as the basis of international and national public advertisements. It is taken as base for an increasing number of product standards (e.g. precast concrete members) and thus a condition for the CE marking for building products. Internationally the Eurocode is accepted as a high standard of quality to which a number of non-european nations also adhere to (e.g. Malaysia, Singapore, Viet Nam, South Africa consider a takeover, interested are Australia, New Zealand, India, China, Mediterranean neighbouring states and a number of Latin American countries).
As a software company on the international market some of our reinforced concrete programs currently already implement the German, the British and the Austrian national annexes, others are in preparation.

Following is a concise review of our current program developments.

Comparison of the bending design after EN 1992 1-1

(Original EN 1992 1-1, DIN EN, ÖNORM EN, BS EN)

In general the stress-strain relation of concrete for design (parabola-rectangle diagram), are identical; however the different peak values for f_{cd} lead to different design results.

ÖNORM: with γ_c = 1,50 and
α_{cc} = 1,00 result
f_{cd} = 13,33 N/mm²
DIN, BS: with γ_c = 1,50 and
α_{cc} = 0,85 arises
f_{cd} = 11,33 N/mm².

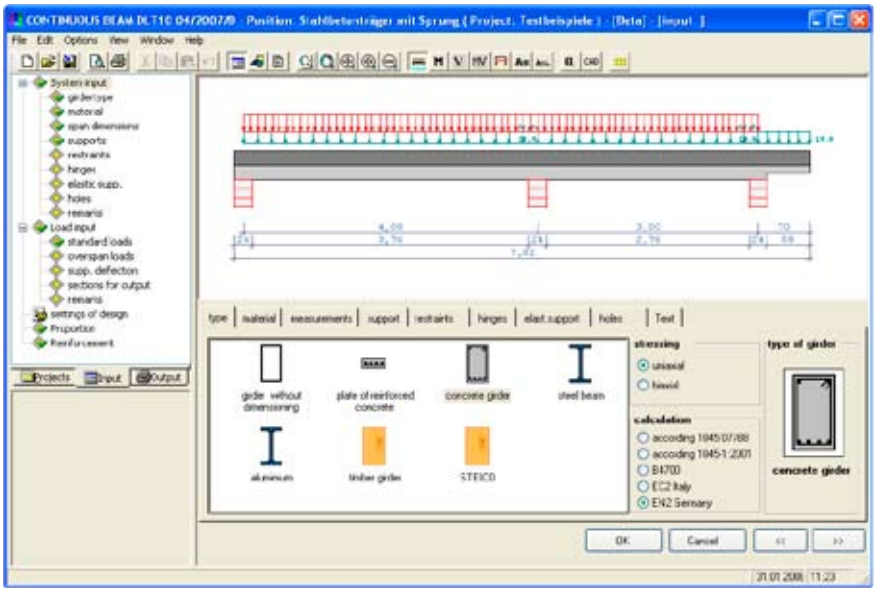


Fig 3 Design of a RC Beam according to DIN EN of 1992 1-1 with the continuous beams program

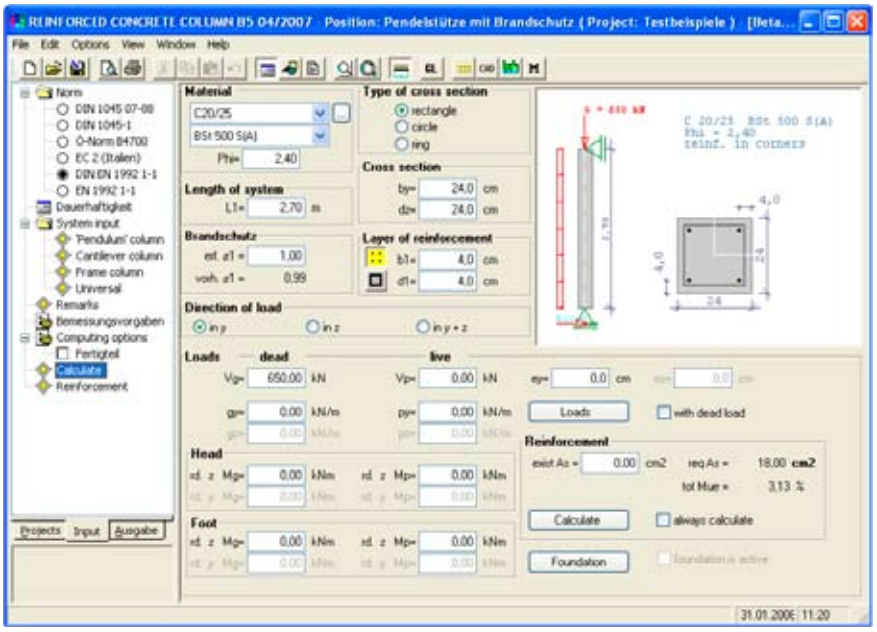
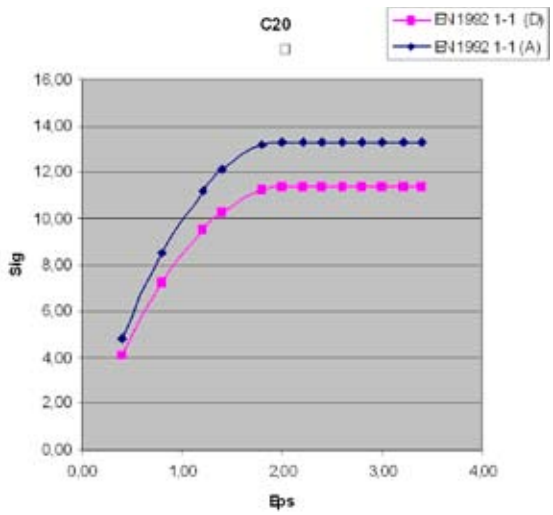
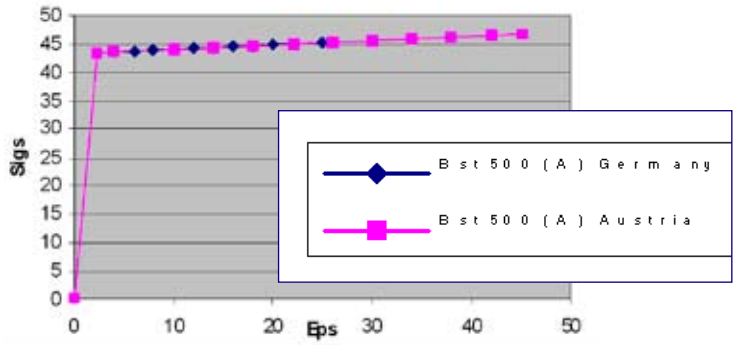


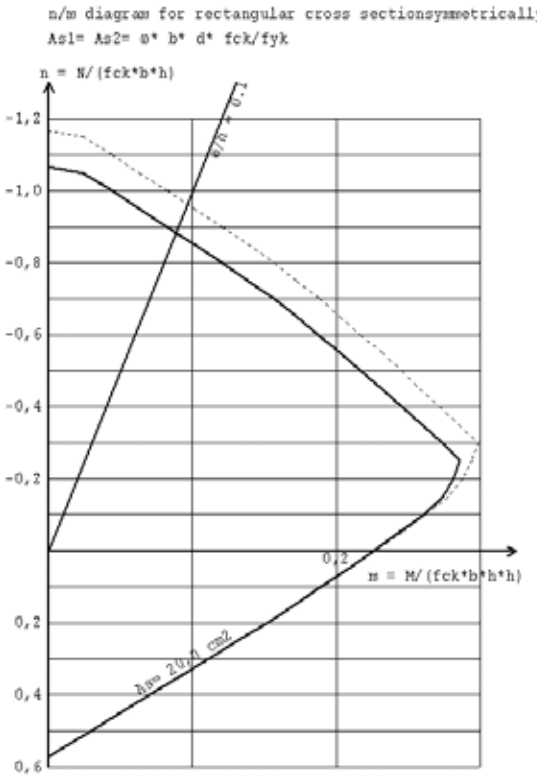
Fig 4 Support design according to DIN EN 1992 1-1 with the reinforced concrete column program



Stress-strain diagrams of steel also differ at limit strains ε_{ud}.

ÖNORM, BS: $0{,}9 \cdot \varepsilon_{uk}$
DIN: 25 ‰





V1: ————
BS BN 1992-1-1 basic combination
concrete C 12/15 C 16/20 C 20/25 C 25/30 C 30/37 C 35/45 C 40/50 C 45/55 C
reinforcing steel B 500A d1/h= 0,10
V2: - - - - - - - - - - - - - -
ÖNORM BN 1992-1-1 basic combination
concrete C 12/15 C 16/20 C 20/25 C 25/30 C 30/37 C 35/45 C 40/50 C 45/55 C
reinforcing steel B 500A d1/h= 0,10

Clearly higher bending resistance results after ÖNORM EN 1992 1-1 as compared to DIN EN 1992 1-1, if pressure is combined with bending. If equal steel strain capacities are used in the calculation, the design results of DIN EN and BS EN work out to be nearly identical.

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