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Connection of New and Old Concrete with Bonded Reinforcement Bars

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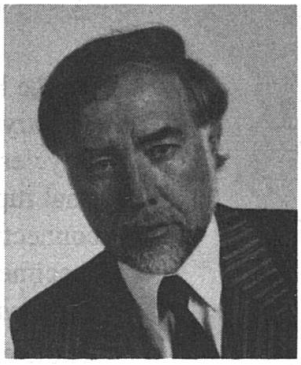


Erich K.R.Wisser, born 1940, formally head of powerhouse planning for hydro-electric plants, international civil engineering in cable way construction and anchor technology, since 1993 at Hilti Corporate Research, prime mover for anchor technology

Summary

In most cases connection of new and old concrete is performed by extending the reinforcement, often by means of post-installed bonded bars. New systems suitable of use on site have been developed, tested and introduced worldwide by Hilti Demolition and Fastening Technology, based on Eurocode 2, Design of Concrete Structures. Now engineers have a tested method to solve such problems as bridge renovation, retrofitting of industrial buildings, enhancement of earthquake resistance, etc.

1. Background Information

To get a monolithic behaviour of concrete structures cast in several parts it is necessary to establish continuity of the existing reinforcing. This can be accomplished either through cast-in-place starter bars or much more often by means of post-installed bonded rebars. Design rules for this applications have not been available up to now.

2. New connection systems

Following observation of jobsite working methods and on basis of experience with adhesive products, two connection systems were developed:

2.1 Rebar connection with HIT-HY 150

A hole is drilled close to a cast-in rebar and cleaned of dust. Adhesive is injected from the back of the hole to the surface using a dispenser. The rebar is then inserted. Owing to the thixotropic formulation of the adhesive, rod insertion can be accomplished vertically downwards, horizontally or vertically upwards.
As a hybrid system, the adhesive HY-150 combines the benefits of resins (fluidity, fast curing, strong compound) with those of cements (insensitive to humidity, post-hardening, heat-resistant) and exhibits the same behaviour as cast-in rebars.

2.2 Rebar connections with HVU

A hole is drilled close to a cast-in rebar and cleaned of dust. A foil cartridge is inserted in the hole and the rod driven through the cartridge with a hammer drill.
This modern resin gains full load capacity in a shorter time, also at temperatures lower than 0°C, has a matrix of high compression strength and shows no creep.

3. Design Concept for Rebar Connections

In cooperation with Prof. Marti [4] design rules were elaborated based on the safety concept of Eurocode 2 [1] and three failure modes:

- Limit of rebar utilisation
- Limit of adhesive bond utilisation
- Limit of concrete bond utilisation

The basic anchorage length (steel fully utilised) derived from tests ([2], [3]) corresponds with the European codes. Also, the splice length in beams show good conformity, given that the appropriate application-specific rules of EC2 are applied to the basic anchorage length (fig. 2).

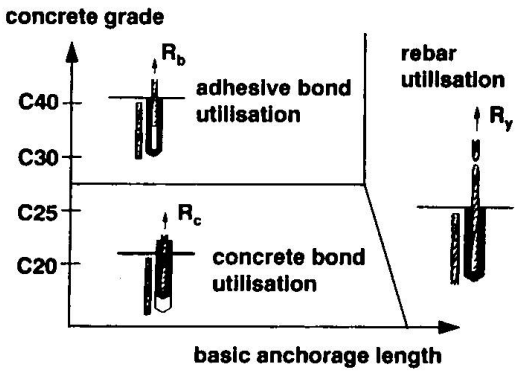
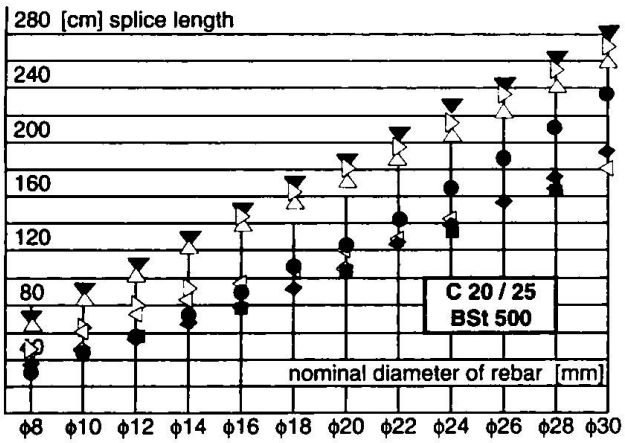


Fig. 1 Design Concept



	EU	GB	D	A	CH	HIT-	
	EC 2	BS 8110	DIN 1045	ÖN B 4200	SIA 162	HY 150	HVU
	▼	△	▷	◆	◁	●	■
ϕ8	75	69	52	37	48	30	[cm]
ϕ10	94	86	66	46	60	44	
ϕ12	113	103	79	55	72	58	58
ϕ14	132	120	92	65	84	74	
ϕ16	150	138	144	78	96	88	78
ϕ18	169	155	162	91	108	108	
ϕ20	188	172	180	106	120	122	104
ϕ22	207	189	198	121	132	144	
ϕ24	226	206	216	138	144	166	132
ϕ26	244	224	235	155	156	188	
ϕ28	263	241	253	173	168	212	164
ϕ30	282	258	271	192	180	236	[cm]

Fig. 2 Comparison of splice length in a beam at different European codes

The pull-out and beam tests verify that the two systems HIT-HY150 and HVU, result in a load-slip relationship nearly identical with that of cast-in-place reinforcing bars. For this reason they are ideally suited for the connection of new with old concrete.

[1] ENV 1992-1-1, Eurocode 2: Design of Concrete Structures
[2] Marti P.: Anchoring Concrete Reinforcement using Hilti HIT-HY150, Report no. 93.327-1, 1993
[3] Marti P.: Anchoring Concrete Reinforcement using HVU, Report no. 93.327-2 and 3
[4] Hilti: Rebar Fastening Guide, Fastening Technology Manual B2.2, 1994