Composite beams in building construction

Composite beams are steel beams, that are tied to a concrete slab by shear connectors such as studs. Ideally, they can bear the own weight of the concrete without props during the construction stage. The composite action starts after the hardening of the concrete so that only the non-structural dead loads and the live loads act on the composite section and the shear connectors. If the steel beam is propped during the assembly, the structural dead loads also act on the composite section after removing the props. The later assembly procedure saves steel, whereas the former reduces the setup costs and the construction time. A further advantage of the former procedure is that it lowers the compression stresses in the concrete slab, reducing the creep deformation.

In the following tables for the pre-dimensioning of reinforced composite beams you will find the bearing capacity Mpl,Rd and Vpl,Rd of composite beams with a steel grade S355 and a concrete grade C30/37. The moment resistance values Mpl,Rd have been determined with no reduction due to the acting shear force and are calculated with effective widths of the concrete flange of 2.5 and 4.0m. As the moment resistance is significantly increased by increasing the concrete cover and the effective concrete width has a smaller effect, the load bearing capacities can be used for other plate widths. Should your parameters be very different from these, please contact out technical office.

The tables are valid for concrete encased beams (Figure 1) and composite beams consisting of a concrete slab resting on a steel beam (Figure 2). There are values for a concrete cover of 10, 12, 15, 20 and 25 cm.
The concrete cover of 10 cm is valid for an encased beam with a concrete slab thickness of at least 20 cm (hc >= 20 cm, cv = 10 cm).
For the remaining concrete covers from 12 to 25cm the slab thickness and the concrete cover have the same value in the calculation (hc=cv), so that the load bearing capacities can be interpolated for other concrete covers between these values. This values can also be used for concrete encased beams. If the plate thickness is higher than the concrete cover in concrete encased beams, the values on the table are conservative.

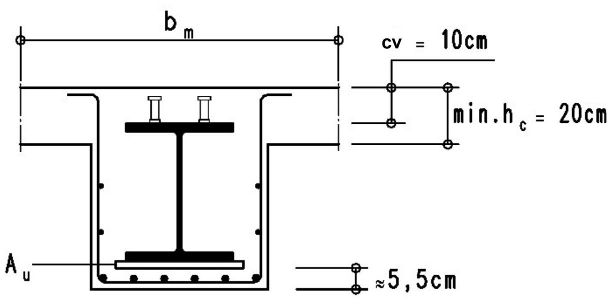

Figure 1:
Concrete encased composite beam

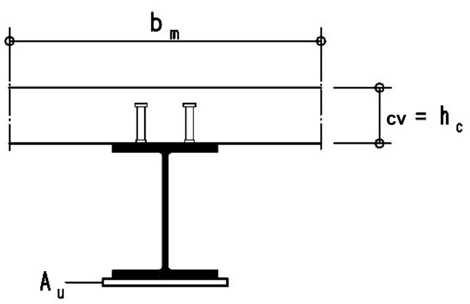

Figure 2:
Composite beam with concrete slab resting on steel beam

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How to use the pre-dimensioning tables:

Example 1: Composite beam with concrete slab on top of steel beam

Parameters: Concrete slab d = 20 cm,
Effective width of concrete flange 2.5m

Support reactions

Permanent loads	$V_{k,g}$	=	220 kN
Imposed loads	$V_{k,q}$	=	172 kN
V_{Ed} = 220 x 1.35 + 172 x 1.5		=	555 kN

Midspan moment:

Permanent loads	$M_{k,g}$	=	550 kNm
Imposed loads	$M_{k,q}$	=	430 kNm
M_{Ed} = 550 x 1.35 + 430 x 1.5		=	1,388 kNm

Chosen: IPE 330 with 40cm² reinforcement steel plate.

$V_{pl,Rd}$ = 631 kN > 555 kN
$M_{pl,Rd}$ = 1,422 kNm > 1,388 kNm

Example 2: Concrete encased composite beam

Parameters: Concrete slab d = 20cm,
Concrete cover cv = 10cm,
Effective plate width 4.0m

Support reactions

Permanent loads	$V_{k,g}$	=	790 kN
Imposed loads	$V_{k,q}$	=	340 kN
V_{Ed} = 220 x 1.35 + 172 x 1.5		=	1,557 kN

Midspan moment:

Permanent loads	$M_{k,g}$	=	3,160 kNm
Imposed loads	$M_{k,q}$	=	1,360 kNm
M_{Ed} = 550 x 1.35 + 430 x 1.5		=	6,306 kNm

Chosen: HE-A 700 with 120cm² reinforcement steel plate.

$V_{pl,Rd}$ = 2,397 kN > 1,557 kN
$M_{pl,Rd}$ = 6,452 kNm > 6,306 kNm

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Pre-dimensioning tables for composite beams HE-A 180 to HE-A 360 with reinforcement plate in bottom flange (A_u)

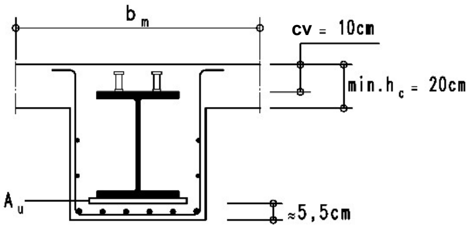
Midspan moments

HE-A	-	180	200	220	240	260	280	300	320	340	360
h [mm]		171	190	210	230	250	270	290	310	330	350
g [kg/m]		35.5	42.3	50.5	60.3	68.2	76.4	88.3	97.6	105.0	112.0
Vpl,Rd [kN]		297	371	424	516	589	651	764	843	921	1,003

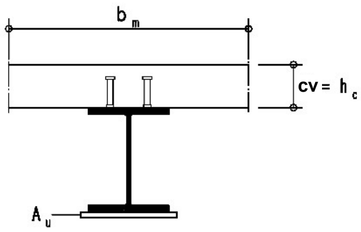
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

These results constitute only indicative information in order to pre-dimension the elements. They cannot be used as the definitive structural design. The definitive structural design is to be carried out by spannverbund. Without a previous contractual arrangement with spannverbund, we assume no liability derived from the misuse of these indications.

A_u [cm2]	cv [cm]	Total effective width b_{eff} = 2.50 m — Plastic moment resistance $M_{pl,Rd}$ [kNm]									
		180	200	220	240	260	280	300	320	340	360
0	10	268	330	407	499	582	671	791	897	994	1,098
	12	300	368	453	553	643	740	871	985	1,086	1,193
	15	348	425	521	635	736	844	991	1,117	1,228	1,345
	20	428	521	635	772	890	1,016	1,190	1,338	1,465	1,598
	25	509	616	749	908	1,044	1,189	1,390	1,559	1,702	1,852
20	10	431	501	586	685	776	874	1,001	1,119	1,229	1,347
	12	477	554	646	754	852	957	1,093	1,214	1,325	1,444
	15	547	632	736	857	966	1,082	1,234	1,368	1,488	1,613
	20	662	763	886	1,029	1,156	1,290	1,469	1,624	1,760	1,902
	25	778	894	1,036	1,201	1,345	1,498	1,704	1,880	2,033	2,191
40	10	589	668	761	867	967	1,075	1,215	1,346	1,470	1,601
	12	650	735	835	950	1,056	1,169	1,311	1,443	1,568	1,700
	15	741	835	946	1,074	1,191	1,315	1,473	1,613	1,742	1,876
	20	892	1,001	1,132	1,282	1,416	1,559	1,743	1,905	2,050	2,200
	25	1,043	1,168	1,317	1,489	1,642	1,803	2,014	2,197	2,358	2,525
60	10	732	820	921	1,036	1,149	1,271	1,424	1,568	1,705	1,849
	12	807	900	1,009	1,130	1,245	1,368	1,522	1,667	1,805	1,949
	15	919	1,022	1,141	1,276	1,401	1,533	1,696	1,844	1,984	2,130
	20	1,106	1,224	1,362	1,519	1,662	1,812	2,002	2,171	2,325	2,484
	25	1,293	1,426	1,583	1,762	1,922	2,092	2,308	2,498	2,668	2,844
80	10	864	961	1,075	1,204	1,330	1,465	1,630	1,788	1,938	2,095
	12	952	1,054	1,171	1,301	1,428	1,564	1,730	1,888	2,039	2,197
	15	1,086	1,197	1,324	1,466	1,599	1,739	1,909	2,069	2,222	2,382
	20	1,308	1,434	1,581	1,744	1,895	2,054	2,249	2,425	2,587	2,755
	25	1,530	1,672	1,837	2,023	2,192	2,369	2,590	2,788	2,966	3,151
100	10		1,100	1,227	1,368	1,508	1,657	1,835	2,005	2,169	2,339
	12		1,197	1,325	1,468	1,608	1,757	1,936	2,107	2,271	2,442
	15		1,360	1,496	1,644	1,786	1,937	2,119	2,293	2,458	2,631
	20		1,633	1,787	1,958	2,117	2,284	2,484	2,667	2,838	3,015
	25		1,906	2,079	2,271	2,449	2,634	2,861	3,065	3,253	3,446
120	10			1,397	1,552	1,705	1,866	2,057	2,240	2,416	2,600
	12			1,498	1,653	1,807	1,969	2,160	2,342	2,517	2,698
	15			1,676	1,834	1,990	2,154	2,348	2,535	2,713	2,899
	20			2,003	2,180	2,348	2,523	2,728	2,919	3,101	3,290
	25			2,331	2,530	2,715	2,909	3,141	3,352	3,549	3,750
140	10				1,734	1,900	2,075	2,278	2,474	2,662	2,858
	12				1,825	1,988	2,157	2,354	2,541	2,721	2,906
	15				2,029	2,198	2,375	2,582	2,781	2,973	3,172
	20				2,399	2,575	2,757	2,969	3,173	3,368	3,570
	25				2,783	2,977	3,179	3,416	3,634	3,840	4,050
160	10					2,065	2,252	2,468	2,676	2,878	3,086
	12					2,062	2,239	2,444	2,640	2,829	3,022
	15					2,381	2,571	2,789	2,999	3,200	3,407
	20					2,769	2,962	3,187	3,403	3,611	3,827
	25					3,206	3,415	3,658	3,884	4,097	4,317
180	10						2,420	2,648	2,869	3,083	3,304
	12						2,265	2,475	2,676	2,871	3,072
	15						2,723	2,946	3,161	3,367	3,580
	20						3,165	3,402	3,631	3,852	4,081
	25						3,640	3,888	4,121	4,346	4,578
200	10							2,818	3,051	3,278	3,512
	12							2,497	2,700	2,895	3,098
	15							3,020	3,244	3,460	3,681
	20							3,614	3,856	4,091	4,332
	25							4,108	4,354	4,591	4,836
HE-A	-	180	200	220	240	260	280	300	320	340	360

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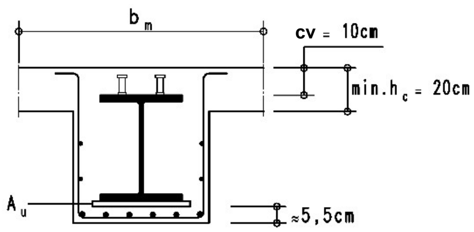
Pre-dimensioning tables for composite beams HE-A 400 to HE-A 1000 with reinforcement plate in bottom flange (A_u)

Midspan moments

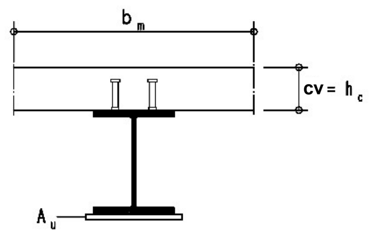
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

These results constitute only indicative information in order to pre-dimension the elements. They cannot be used as the definitive structural design. The definitive structural design is to be carried out by spannverbund. Without a previous contractual arrangement with spannverbund, we assume no liability derived from the misuse of these indications.

HE-A	-	400	450	500	550	600	650	700	800	900	1000
h [mm]		171	190	210	230	250	270	290	310	330	350
g [kg/m]		35.5	42.3	50.5	60.3	68.2	76.4	88.3	97.6	105.0	112.0
Vpl,Rd [kN]		1,175	1,348	1,531	1,716	1,910	2,115	2,397	2,845	3,348	3,783

A_u [cm2]	cv [cm]	Total effective width b_{eff} = 4.00 m Plastic moment resistance $M_{pl,Rd}$ [kNm]									
0	10	1,431	1,729	2,058	2,369	2,709	3,079	3,519	4,328	5,366	6,380
	12	1,544	1,855	2,198	2,516	2,861	3,234	3,677	4,488	5,529	6,544
	15	1,713	2,045	2,408	2,742	3,102	3,491	3,949	4,773	5,825	6,849
	20	1,995	2,361	2,759	3,118	3,504	3,920	4,411	5,280	6,387	7,443
	25	2,277	2,677	3,110	3,494	3,906	4,348	4,873	5,788	6,956	8,058
20	10	1,720	2,046	2,408	2,753	3,127	3,532	4,006	4,883	5,988	7,071
	12	1,847	2,187	2,558	2,906	3,283	3,690	4,166	5,045	6,152	7,235
	15	2,037	2,397	2,789	3,153	3,544	3,962	4,448	5,336	6,456	7,548
	20	2,355	2,749	3,176	3,564	3,981	4,426	4,946	5,877	7,042	8,159
	25	2,673	3,100	3,562	3,976	4,418	4,891	5,444	6,420	7,647	8,810
40	10	2,008	2,368	2,763	3,142	3,551	3,989	4,497	5,443	6,616	7,768
	12	2,149	2,518	2,918	3,299	3,709	4,150	4,659	5,606	6,781	7,932
	15	2,361	2,750	3,170	3,564	3,985	4,433	4,949	5,905	7,091	8,251
	20	2,714	3,137	3,592	4,011	4,458	4,933	5,481	6,474	7,697	8,875
	25	3,068	3,524	4,013	4,458	4,930	5,433	6,014	7,052	8,337	9,561
60	10	2,291	2,684	3,113	3,527	3,969	4,442	4,983	5,998	7,239	8,459
	12	2,441	2,838	3,270	3,686	4,130	4,604	5,147	6,162	7,403	8,622
	15	2,674	3,091	3,540	3,964	4,415	4,894	5,443	6,467	7,720	8,948
	20	3,063	3,514	3,997	4,446	4,923	5,428	6,005	7,059	8,340	9,583
	25	3,452	3,936	4,454	4,929	5,431	5,963	6,574	7,673	9,016	10,302
80	10	2,571	2,998	3,461	3,909	4,385	4,892	5,468	6,551	7,860	9,148
	12	2,726	3,156	3,621	4,070	4,548	5,056	5,632	6,715	8,023	9,306
	15	2,980	3,425	3,902	4,357	4,839	5,353	5,935	7,027	8,347	9,642
	20	3,404	3,883	4,395	4,874	5,381	5,916	6,521	7,637	8,979	10,289
	25	3,828	4,341	4,887	5,392	5,925	6,487	7,126	8,287	9,688	11,035
100	10	2,850	3,311	3,807	4,289	4,800	5,341	5,950	7,102	8,479	9,835
	12	3,008	3,471	3,969	4,452	4,964	5,505	6,114	7,266	8,637	9,965
	15	3,278	3,752	4,258	4,745	5,262	5,809	6,424	7,584	8,971	10,335
	20	3,738	4,246	4,785	5,295	5,832	6,397	7,030	8,208	9,614	10,993
	25	4,197	4,739	5,313	5,848	6,411	7,003	7,670	8,893	10,352	11,760
120	10	3,148	3,643	4,173	4,689	5,234	5,809	6,452	7,672	9,116	10,537
	12	3,308	3,805	4,336	4,853	5,398	5,974	6,616	7,833	9,247	10,603
	15	3,590	4,093	4,632	5,153	5,704	6,284	6,933	8,161	9,614	11,046
	20	4,085	4,622	5,190	5,730	6,296	6,891	7,553	8,796	10,269	11,715
	25	4,581	5,151	5,753	6,318	6,911	7,533	8,229	9,513	11,030	12,500
140	10	3,452	3,980	4,544	5,094	5,673	6,283	6,959	8,247	9,755	11,241
	12	3,614	4,143	4,708	5,259	5,838	6,447	7,120	8,384	9,820	11,204
	15	3,903	4,439	5,010	5,566	6,150	6,764	7,446	8,742	10,262	11,757
	20	4,433	4,997	5,594	6,164	6,761	7,385	8,078	9,388	10,928	12,443
	25	4,963	5,562	6,193	6,788	7,411	8,063	8,787	10,133	11,708	13,239
160	10	3,732	4,294	4,892	5,476	6,090	6,733	7,441	8,794	10,366	11,918
	12	3,895	4,458	5,056	5,641	6,252	6,888	7,574	8,867	10,327	11,742
	15	4,191	4,761	5,365	5,954	6,572	7,220	7,936	9,299	10,882	12,418
	20	4,751	5,344	5,969	6,569	7,196	7,853	8,579	9,957	11,564	13,146
	25	5,317	5,944	6,603	7,229	7,882	8,564	9,316	10,724	12,357	13,954
180	10	4,011	4,606	5,238	5,856	6,502	7,177	7,918	9,336	10,972	12,589
	12	4,175	4,771	5,399	6,008	6,638	7,287	7,980	9,304	10,790	12,236
	15	4,478	5,080	5,718	6,341	6,992	7,674	8,423	9,851	11,472	13,036
	20	5,062	5,684	6,337	6,968	7,628	8,318	9,077	10,524	12,198	13,848
	25	5,664	6,319	7,007	7,663	8,346	9,057	9,838	11,307	13,002	14,667
200	10	4,285	4,914	5,578	6,229	6,908	7,616	8,388	9,872	11,572	13,253
	12	4,443	5,060	5,705	6,328	6,970	7,633	8,336	9,693	11,208	12,688
	15	4,761	5,397	6,068	6,725	7,410	8,126	8,904	10,375	12,018	13,611
	20	5,366	6,016	6,698	7,363	8,057	8,781	9,573	11,088	12,829	14,547
	25	6,003	6,687	7,403	8,089	8,802	9,543	10,353	11,884	13,644	15,377
HE-A	-	400	450	500	550	600	650	700	800	900	1000

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Pre-dimensioning tables for composite beams HE-B 180 to HE-B 360 with reinforcement plate in bottom flange (A_u)

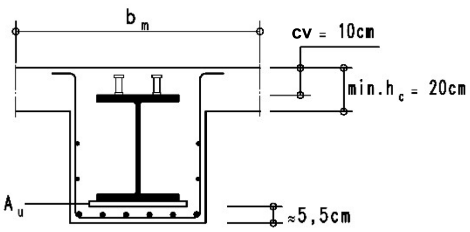
Midspan moments

HE-B	-	180	200	220	240	260	280	300	320	340	360
h [mm]		180	200	220	240	260	280	300	320	340	360
g [kg/m]		51.2	61.3	71.5	83.2	93.0	103.0	117.0	127.0	134.0	142.0
Vpl,Rd [kN]		415	509	572	681	771	842	972	1,061	1,150	1,242

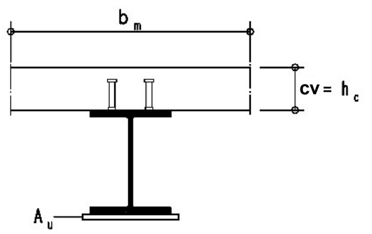
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

These results constitute only indicative information in order to pre-dimension the elements. They cannot be used as the definitive structural design. The definitive structural design is to be carried out by spannverbund. Without a previous contractual arrangement with spannverbund, we assume no liability derived from the misuse of these indications.

A_u [cm2]	cv [cm]	Total effective width b_{eff} = 2.50 m — Plastic moment resistance $M_{pl,Rd}$ [kNm]									
		180	200	220	240	260	280	300	320	340	360
0	10	377	464	556	661	759	865	1,004	1,125	1,237	1,357
	12	423	519	620	736	843	957	1,100	1,222	1,335	1,456
	15	493	603	717	849	969	1,097	1,258	1,390	1,508	1,632
	20	609	741	879	1,037	1,180	1,330	1,523	1,676	1,812	1,953
	25	724	880	1,041	1,226	1,390	1,563	1,787	1,962	2,115	2,274
20	10	535	628	727	838	946	1,065	1,217	1,350	1,476	1,609
	12	595	698	805	927	1,040	1,161	1,314	1,449	1,576	1,710
	15	686	802	924	1,061	1,188	1,322	1,487	1,625	1,754	1,890
	20	837	976	1,121	1,285	1,434	1,590	1,787	1,947	2,091	2,241
	25	989	1,151	1,318	1,508	1,679	1,859	2,087	2,269	2,430	2,597
40	10	688	788	894	1,017	1,138	1,270	1,434	1,581	1,720	1,867
	12	762	872	986	1,112	1,235	1,368	1,534	1,681	1,821	1,968
	15	874	997	1,125	1,268	1,402	1,542	1,712	1,862	2,004	2,153
	20	1,061	1,207	1,358	1,527	1,683	1,846	2,046	2,214	2,366	2,524
	25	1,248	1,417	1,591	1,786	1,964	2,150	2,382	2,571	2,741	2,916
60	10	826	936	1,055	1,190	1,324	1,469	1,647	1,806	1,958	2,118
	12	914	1,030	1,151	1,288	1,424	1,569	1,747	1,907	2,060	2,221
	15	1,048	1,177	1,311	1,459	1,600	1,748	1,930	2,092	2,247	2,409
	20	1,270	1,422	1,580	1,754	1,917	2,086	2,290	2,464	2,626	2,792
	25	1,492	1,667	1,848	2,049	2,233	2,426	2,662	2,857	3,036	3,219
80	10	958	1,081	1,213	1,361	1,508	1,667	1,857	2,029	2,195	2,368
	12	1,054	1,179	1,312	1,461	1,609	1,768	1,959	2,131	2,297	2,471
	15	1,209	1,345	1,486	1,639	1,790	1,951	2,145	2,320	2,488	2,664
	20	1,467	1,625	1,789	1,969	2,139	2,315	2,523	2,704	2,875	3,054
	25	1,724	1,906	2,093	2,299	2,491	2,690	2,929	3,132	3,319	3,511
100	10		1,223	1,368	1,529	1,690	1,862	2,065	2,250	2,429	2,615
	12		1,323	1,469	1,631	1,792	1,964	2,167	2,353	2,532	2,718
	15		1,501	1,650	1,815	1,978	2,152	2,358	2,546	2,727	2,916
	20		1,817	1,987	2,172	2,349	2,531	2,744	2,937	3,121	3,313
	25		2,133	2,326	2,538	2,736	2,942	3,185	3,395	3,590	3,791
120	10			1,542	1,716	1,890	2,075	2,290	2,488	2,679	2,878
	12			1,644	1,819	1,993	2,177	2,390	2,586	2,773	2,966
	15			1,831	2,008	2,184	2,371	2,590	2,791	2,985	3,187
	20			2,195	2,385	2,568	2,759	2,983	3,188	3,386	3,591
	25			2,569	2,786	2,991	3,204	3,450	3,667	3,871	4,080
140	10				1,902	2,089	2,287	2,514	2,724	2,928	3,139
	12				1,986	2,168	2,358	2,577	2,777	2,970	3,168
	15				2,206	2,395	2,595	2,827	3,040	3,247	3,461
	20				2,594	2,787	2,991	3,227	3,445	3,655	3,873
	25				3,030	3,242	3,460	3,711	3,934	4,148	4,370
160	10					2,258	2,468	2,708	2,931	3,147	3,370
	12					2,252	2,450	2,677	2,885	3,086	3,292
	15					2,579	2,791	3,031	3,252	3,466	3,685
	20					2,982	3,198	3,447	3,678	3,901	4,132
	25					3,459	3,684	3,939	4,174	4,401	4,636
180	10						2,640	2,892	3,127	3,356	3,592
	12						2,486	2,720	2,936	3,145	3,360
	15						2,937	3,182	3,410	3,629	3,854
	20						3,403	3,665	3,908	4,145	4,389
	25						3,898	4,164	4,412	4,652	4,899
200	10							3,066	3,314	3,555	3,803
	12							2,746	2,964	3,175	3,393
	15							3,269	3,505	3,733	3,967
	20							3,880	4,136	4,386	4,642
	25							4,387	4,647	4,900	5,161
HE-B	-	180	200	220	240	260	280	300	320	340	360

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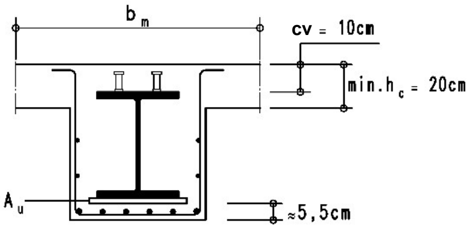
Pre-dimensioning tables for composite beams HE-B 400 to HE-B 1000 with reinforcement plate in bottom flange (A_u)

Midspan moments

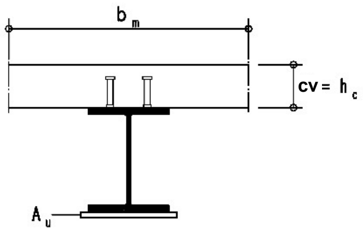
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

These results constitute only indicative information in order to pre-dimension the elements. They cannot be used as the definitive structural design. The definitive structural design is to be carried out by spannverbund. Without a previous contractual arrangement with spannverbund, we assume no liability derived from the misuse of these indications.

HE-B	-	400	450	500	550	600	650	700	800	900	1000
h [mm]		400	450	500	550	600	650	700	800	900	1,000
g [kg/m]		155.0	171.0	187.0	199.0	212.0	225.0	241.0	262.0	291.0	314.0
Vpl,Rd [kN]		1,434	1,633	1,841	2,051	2,271	2,501	2,810	3,315	3,869	4,355
A_u [cm2]	cv [cm]	Total effective width b_{eff} = 4.00 m Plastic moment resistance $M_{pl,Rd}$ [kNm]									
0	10	1,744	2,080	2,453	2,811	3,201	3,623	4,117	5,039	6,197	7,342
	12	1,884	2,229	2,607	2,968	3,360	3,784	4,279	5,203	6,362	7,505
	15	2,095	2,462	2,861	3,235	3,637	4,069	4,571	5,504	6,675	7,828
	20	2,446	2,848	3,285	3,686	4,116	4,577	5,112	6,083	7,290	8,460
	25	2,797	3,235	3,708	4,137	4,596	5,085	5,656	6,676	7,949	9,168
20	10	2,030	2,399	2,806	3,199	3,622	4,079	4,606	5,596	6,823	8,035
	12	2,180	2,554	2,964	3,358	3,784	4,241	4,769	5,761	6,986	8,197
	15	2,412	2,807	3,234	3,638	4,070	4,533	5,068	6,069	7,307	8,527
	20	2,799	3,229	3,693	4,124	4,584	5,074	5,637	6,669	7,933	9,170
	25	3,185	3,651	4,152	4,611	5,099	5,618	6,217	7,298	8,628	9,907
40	10	2,322	2,724	3,165	3,591	4,049	4,539	5,100	6,159	7,453	8,734
	12	2,476	2,882	3,325	3,753	4,212	4,703	5,264	6,323	7,616	8,894
	15	2,729	3,151	3,606	4,040	4,505	5,001	5,570	6,638	7,943	9,231
	20	3,151	3,609	4,101	4,562	5,052	5,571	6,162	7,255	8,581	9,885
	25	3,573	4,067	4,596	5,084	5,602	6,150	6,777	7,919	9,306	10,646
60	10	2,608	3,044	3,518	3,979	4,471	4,995	5,589	6,717	8,078	9,427
	12	2,765	3,204	3,680	4,142	4,634	5,159	5,754	6,880	8,239	9,580
	15	3,034	3,485	3,969	4,436	4,934	5,464	6,066	7,202	8,573	9,929
	20	3,492	3,978	4,498	4,989	5,508	6,057	6,676	7,830	9,223	10,595
	25	3,950	4,472	5,028	5,546	6,094	6,672	7,327	8,529	9,973	11,374
80	10	2,892	3,362	3,869	4,364	4,890	5,448	6,076	7,272	8,701	10,119
	12	3,051	3,523	4,033	4,528	5,054	5,613	6,240	7,435	8,857	10,240
	15	3,333	3,812	4,328	4,829	5,361	5,925	6,559	7,763	9,201	10,624
	20	3,826	4,340	4,888	5,408	5,957	6,535	7,183	8,403	9,862	11,301
	25	4,319	4,869	5,453	6,001	6,578	7,186	7,869	9,132	10,633	12,094
100	10	3,174	3,678	4,219	4,748	5,308	5,900	6,562	7,826	9,323	10,805
	12	3,336	3,841	4,383	4,912	5,472	6,064	6,725	7,986	9,451	10,864
	15	3,624	4,136	4,686	5,220	5,785	6,383	7,050	8,322	9,827	11,317
	20	4,152	4,695	5,270	5,820	6,399	7,007	7,686	8,973	10,499	12,006
	25	4,681	5,259	5,871	6,449	7,056	7,692	8,404	9,727	11,286	12,810
120	10	3,476	4,013	4,588	5,151	5,745	6,371	7,067	8,399	9,960	11,507
	12	3,639	4,177	4,752	5,315	5,909	6,534	7,227	8,538	10,029	11,471
	15	3,934	4,479	5,062	5,630	6,229	6,860	7,560	8,900	10,471	12,023
	20	4,493	5,063	5,666	6,246	6,855	7,495	8,207	9,562	11,154	12,729
	25	5,057	5,663	6,303	6,910	7,547	8,213	8,952	10,337	11,954	13,545
140	10	3,783	4,354	4,962	5,559	6,188	6,848	7,577	8,975	10,599	12,211
	12	3,947	4,518	5,126	5,723	6,350	7,006	7,717	9,060	10,575	12,048
	15	4,249	4,827	5,443	6,044	6,677	7,341	8,075	9,482	11,115	12,707
	20	4,833	5,431	6,062	6,673	7,314	7,988	8,733	10,156	11,815	13,457
	25	5,432	6,067	6,734	7,371	8,037	8,733	9,500	10,945	12,625	14,284
160	10	4,067	4,671	5,314	5,945	6,607	7,300	8,060	9,524	11,211	12,887
	12	4,231	4,835	5,477	6,104	6,755	7,427	8,147	9,521	11,062	12,567
	15	4,540	5,151	5,800	6,435	7,101	7,799	8,566	10,039	11,712	13,333
	20	5,144	5,770	6,431	7,075	7,750	8,457	9,236	10,726	12,452	14,162
	25	5,779	6,441	7,137	7,804	8,499	9,224	10,020	11,527	13,274	15,000
180	10	4,349	4,987	5,662	6,327	7,021	7,747	8,539	10,066	11,818	13,557
	12	4,512	5,146	5,810	6,455	7,119	7,805	8,535	9,940	11,511	13,048
	15	4,829	5,473	6,155	6,824	7,524	8,255	9,054	10,574	12,271	13,921
	20	5,448	6,104	6,797	7,475	8,184	8,924	9,736	11,294	13,086	14,864
	25	6,118	6,809	7,532	8,229	8,954	9,708	10,532	12,106	13,919	15,713
200	10	4,627	5,298	6,006	6,703	7,430	8,188	9,011	10,604	12,418	14,222
	12	4,771	5,421	6,100	6,758	7,438	8,139	8,881	10,319	11,921	13,491
	15	5,115	5,793	6,507	7,210	7,943	8,704	9,518	11,069	12,791	14,472
	20	5,746	6,434	7,161	7,872	8,615	9,389	10,234	11,860	13,718	15,564
	25	6,450	7,169	7,920	8,647	9,401	10,185	11,042	12,683	14,563	16,424
HE-B	-	400	450	500	550	600	650	700	800	900	1000

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Version 04/2018

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Pre-dimensioning tables for composite beams HE-M 180 to HE-M 360 with reinforcement plate in bottom flange (A_u)

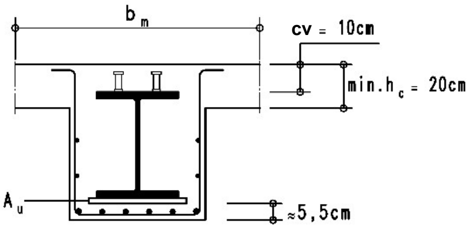
Midspan moments

HE-M	-	180	200	220	240	260	280	300	320	340	360
h [mm]		200	220	240	270	290	310	340	359	377	395
g [kg/m]		88.9	103.0	117.0	157.0	172.0	189.0	238.0	245.0	248.0	250.0
Vpl,Rd [kN]		710	841	929	1,231	1,371	1,476	1,855	1,944	2,021	2,099

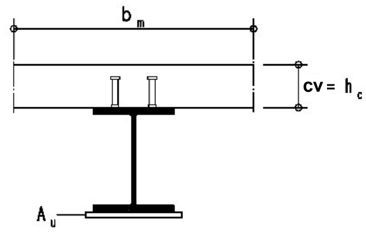
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

These results constitute only indicative information in order to pre-dimension the elements. They cannot be used as the definitive structural design. The definitive structural design is to be carried out by spannverbund. Without a previous contractual arrangement with spannverbund, we assume no liability derived from the misuse of these indications.

A_u [cm2]	cv [cm]	Total effective width b_{eff} = 2.50 m									
		Plastic moment resistance $M_{pl,Rd}$ [kNm]									
HE-M	-	180	200	220	240	260	280	300	320	340	360
0	10	614	725	846	1,150	1,316	1,496	1,959	2,110	2,232	2,350
	12	694	816	942	1,251	1,418	1,599	2,062	2,213	2,334	2,453
	15	815	956	1,101	1,433	1,603	1,788	2,264	2,416	2,538	2,658
	20	1,016	1,189	1,367	1,783	1,975	2,172	2,667	2,823	2,947	3,067
	25	1,217	1,422	1,632	2,137	2,365	2,598	3,157	3,316	3,441	3,562
20	10	759	882	1,015	1,335	1,513	1,706	2,185	2,349	2,482	2,614
	12	852	978	1,114	1,437	1,616	1,809	2,288	2,451	2,585	2,716
	15	994	1,139	1,287	1,624	1,806	2,003	2,493	2,658	2,793	2,924
	20	1,230	1,407	1,588	1,996	2,190	2,394	2,904	3,072	3,208	3,341
	25	1,467	1,676	1,889	2,386	2,615	2,851	3,401	3,572	3,709	3,843
40	10	909	1,043	1,189	1,524	1,715	1,921	2,416	2,592	2,739	2,882
	12	1,006	1,142	1,289	1,627	1,818	2,024	2,518	2,694	2,840	2,983
	15	1,168	1,316	1,469	1,819	2,014	2,223	2,728	2,905	3,052	3,196
	20	1,440	1,620	1,805	2,204	2,405	2,621	3,145	3,326	3,474	3,619
	25	1,712	1,924	2,141	2,629	2,861	3,099	3,649	3,833	3,982	4,128
60	10	1,051	1,198	1,356	1,708	1,912	2,131	2,642	2,831	2,989	3,145
	12	1,151	1,299	1,458	1,811	2,014	2,234	2,743	2,931	3,089	3,245
	15	1,327	1,480	1,644	2,008	2,215	2,436	2,956	3,146	3,305	3,462
	20	1,634	1,818	2,006	2,401	2,614	2,842	3,381	3,574	3,734	3,892
	25	1,942	2,158	2,378	2,858	3,092	3,331	3,891	4,087	4,249	4,408
80	10	1,191	1,350	1,521	1,889	2,106	2,338	2,866	3,067	3,238	3,406
	12	1,293	1,452	1,624	1,992	2,208	2,440	2,965	3,165	3,335	3,502
	15	1,476	1,640	1,815	2,194	2,413	2,648	3,183	3,385	3,556	3,725
	20	1,817	2,004	2,195	2,596	2,821	3,060	3,614	3,820	3,992	4,162
	25	2,160	2,379	2,602	3,074	3,311	3,557	4,131	4,340	4,514	4,685
100	10		1,499	1,683	2,068	2,298	2,544	3,087	3,301	3,484	3,664
	12		1,602	1,786	2,170	2,399	2,643	3,177	3,386	3,565	3,739
	15		1,796	1,983	2,377	2,609	2,856	3,407	3,621	3,805	3,986
	20		2,178	2,374	2,788	3,024	3,276	3,845	4,063	4,248	4,430
	25		2,589	2,815	3,279	3,522	3,780	4,369	4,590	4,776	4,960
120	10			1,864	2,265	2,508	2,766	3,325	3,551	3,745	3,937
	12			1,964	2,357	2,594	2,845	3,383	3,599	3,784	3,964
	15			2,169	2,579	2,823	3,084	3,650	3,876	4,071	4,262
	20			2,569	2,998	3,247	3,511	4,095	4,325	4,523	4,717
	25			3,038	3,497	3,753	4,023	4,626	4,859	5,058	5,254
140	10				2,463	2,718	2,988	3,563	3,800	4,006	4,209
	12				2,515	2,760	3,017	3,563	3,785	3,976	4,163
	15				2,784	3,041	3,313	3,886	4,121	4,323	4,522
	20				3,212	3,473	3,751	4,350	4,592	4,802	5,009
	25				3,720	3,987	4,270	4,887	5,133	5,344	5,553
160	10					2,898	3,180	3,771	4,020	4,237	4,451
	12					2,864	3,129	3,687	3,916	4,113	4,307
	15					3,216	3,493	4,071	4,312	4,521	4,726
	20					3,676	3,966	4,581	4,836	5,058	5,277
	25					4,198	4,493	5,125	5,384	5,607	5,828
180	10						3,364	3,970	4,231	4,459	4,684
	12						3,203	3,777	4,013	4,217	4,417
	15						3,636	4,222	4,470	4,685	4,897
	20						4,180	4,809	5,076	5,309	5,539
	25						4,713	5,361	5,632	5,867	6,101
200	10							4,161	4,433	4,672	4,906
	12							3,836	4,078	4,287	4,493
	15							4,339	4,594	4,816	5,033
	20							5,024	5,299	5,540	5,777
	25							5,594	5,877	6,126	6,371
HE-M	-	180	200	220	240	260	280	300	320	340	360

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Version 04/2018

spannverbund

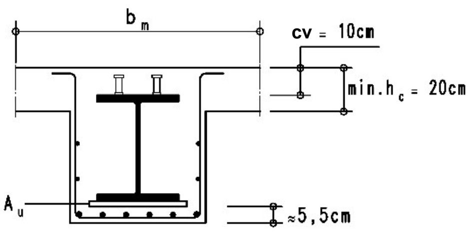
Pre-dimensioning tables for composite beams HE-M 400 to HE-M 1000 with reinforcement plate in bottom flange (A_u)

Midspan moments

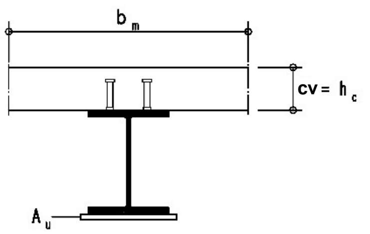
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

These results constitute only indicative information in order to pre-dimension the elements. They cannot be used as the definitive structural design. The definitive structural design is to be carried out by spannverbund. Without a previous contractual arrangement with spannverbund, we assume no liability derived from the misuse of these indications.

HE-M	-	400	450	500	550	600	650	700	800	900	1000
h [mm]		432	478	524	572	620	668	716	814	910	1,008
g [kg/m]		256.0	263.0	270.0	278.0	285.0	293.0	301.0	317.0	333.0	349.0
Vpl,Rd [kN]		2,258	2,456	2,654	2,861	3,067	3,274	3,481	3,982	4,395	4,817
A_u [cm2]	cv [cm]	Total effective width b_{eff} = 4.00 m									
		Plastic moment resistance $M_{pl,Rd}$ [kNm]									
0	10	2,798	3,140	3,490	3,878	4,275	4,697	5,125	6,078	7,060	8,143
	12	2,961	3,303	3,654	4,043	4,440	4,861	5,289	6,242	7,222	8,302
	15	3,259	3,604	3,958	4,350	4,750	5,175	5,606	6,566	7,553	8,640
	20	3,828	4,185	4,548	4,950	5,359	5,791	6,228	7,200	8,198	9,297
	25	4,406	4,780	5,159	5,579	6,004	6,454	6,908	7,914	8,939	10,062
20	10	3,095	3,469	3,851	4,272	4,703	5,157	5,619	6,640	7,688	8,838
	12	3,259	3,633	4,015	4,437	4,867	5,321	5,782	6,801	7,848	8,995
	15	3,563	3,941	4,326	4,751	5,184	5,641	6,106	7,133	8,185	9,340
	20	4,155	4,542	4,935	5,367	5,806	6,269	6,739	7,778	8,841	10,008
	25	4,769	5,173	5,581	6,031	6,487	6,967	7,451	8,520	9,606	10,790
40	10	3,398	3,803	4,217	4,672	5,135	5,623	6,118	7,206	8,321	9,539
	12	3,562	3,967	4,381	4,836	5,298	5,785	6,279	7,366	8,478	9,689
	15	3,873	4,282	4,698	5,156	5,622	6,113	6,610	7,704	8,823	10,044
	20	4,483	4,898	5,321	5,784	6,255	6,751	7,254	8,360	9,490	10,723
	25	5,132	5,565	6,003	6,483	6,969	7,480	7,995	9,125	10,272	11,518
60	10	3,695	4,132	4,578	5,066	5,562	6,083	6,611	7,768	8,948	10,234
	12	3,859	4,296	4,741	5,229	5,724	6,244	6,771	7,925	9,099	10,357
	15	4,177	4,617	5,065	5,556	6,055	6,578	7,108	8,269	9,454	10,743
	20	4,800	5,245	5,698	6,195	6,699	7,228	7,764	8,937	10,133	11,433
	25	5,484	5,946	6,413	6,924	7,441	7,982	8,527	9,719	10,927	12,239
80	10	3,990	4,459	4,937	5,458	5,988	6,542	7,103	8,327	9,574	10,925
	12	4,153	4,622	5,099	5,619	6,148	6,701	7,261	8,478	9,698	10,992
	15	4,478	4,949	5,429	5,953	6,485	7,041	7,604	8,833	10,083	11,439
	20	5,112	5,589	6,074	6,603	7,141	7,702	8,271	9,511	10,773	12,140
	25	5,829	6,320	6,816	7,358	7,905	8,476	9,052	10,306	11,579	12,958
100	10	4,284	4,785	5,294	5,849	6,412	6,999	7,593	8,885	10,196	11,612
	12	4,446	4,946	5,454	6,007	6,569	7,155	7,745	9,009	10,265	11,594
	15	4,777	5,280	5,792	6,348	6,913	7,502	8,098	9,393	10,710	12,127
	20	5,422	5,931	6,447	7,009	7,580	8,174	8,776	10,083	11,411	12,845
	25	6,166	6,686	7,212	7,784	8,361	8,963	9,570	10,889	12,228	13,674
120	10	4,597	5,130	5,671	6,259	6,855	7,475	8,102	9,460	10,834	12,313
	12	4,757	5,289	5,829	6,415	7,007	7,618	8,229	9,529	10,819	12,182
	15	5,095	5,629	6,173	6,762	7,360	7,982	8,611	9,973	11,350	12,813
	20	5,751	6,291	6,839	7,434	8,038	8,665	9,300	10,674	12,067	13,569
	25	6,517	7,066	7,621	8,223	8,832	9,465	10,105	11,492	12,896	14,409
140	10	4,916	5,480	6,053	6,674	7,303	7,956	8,616	10,037	11,474	13,017
	12	5,073	5,636	6,206	6,817	7,430	8,060	8,688	10,023	11,346	12,745
	15	5,417	5,984	6,558	7,181	7,812	8,467	9,129	10,553	11,974	13,472
	20	6,085	6,656	7,236	7,864	8,501	9,161	9,829	11,270	12,729	14,298
	25	6,868	7,446	8,031	8,665	9,306	9,972	10,645	12,098	13,569	15,149
160	10	5,211	5,807	6,412	7,066	7,727	8,412	9,102	10,587	12,086	13,693
	12	5,363	5,951	6,540	7,170	7,800	8,446	9,091	10,461	11,819	13,252
	15	5,717	6,314	6,921	7,576	8,240	8,927	9,619	11,087	12,543	14,076
	20	6,395	6,998	7,610	8,271	8,940	9,633	10,334	11,842	13,367	15,003
	25	7,190	7,799	8,415	9,082	9,756	10,455	11,161	12,682	14,218	15,866
180	10	5,505	6,133	6,768	7,453	8,145	8,861	9,583	11,131	12,693	14,363
	12	5,631	6,236	6,841	7,488	8,135	8,799	9,461	10,865	12,257	13,725
	15	6,013	6,643	7,281	7,969	8,662	9,374	10,085	11,589	13,079	14,647
	20	6,703	7,338	7,981	8,675	9,377	10,103	10,836	12,412	14,002	15,706
	25	7,509	8,149	8,797	9,497	10,204	10,936	11,675	13,263	14,865	16,580
200	10	5,795	6,453	7,118	7,834	8,558	9,305	10,059	11,670	13,294	15,027
	12	5,866	6,487	7,109	7,773	8,437	9,117	9,797	11,236	12,662	14,164
	15	6,308	6,969	7,635	8,347	9,060	9,789	10,518	12,057	13,581	15,183
	20	7,008	7,675	8,349	9,076	9,811	10,570	11,337	12,979	14,636	16,397
	25	7,826	8,498	9,177	9,910	10,650	11,415	12,187	13,841	15,509	17,291
HE-M	-	400	450	500	550	600	650	700	800	900	1000

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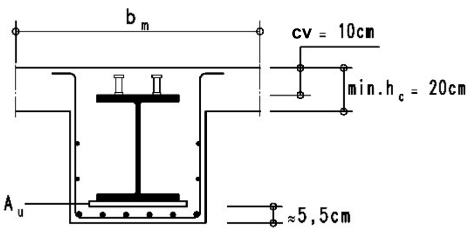
Pre-dimensioning tables for composite beams IPE 180 to IPE 600 with reinforcement plate in bottom flange (A_u)

Midspan moments

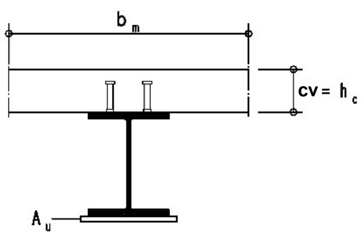
Information about the tables:

Concrete strength C30/37
Steel yield strength f_{yd} = 355 N/mm²
$V_{Ed}/V_{pl,Rd} \leq 0,5$
Full shear connection

The top row for each of the Au values, with a concrete cover of cv = 10cm is valid for concrete encased composite beams with a minimum slab thickness of 20 cm.



The rows with a concrete cover cv = 12 to 25 cm are valid for a composite beam consisting of a concrete slab with a minimum thickness of d = cv laying on a steel beam.
For other concrete covers the load bearing capacities can be interpolated between the values for cv = 12 and cv = 25 cm.
The load-bearing capacities can be used also for concrete encased composite beams.



The plate dimensions for the reinforcement of the bottom flange (Au) can be chosen at will (i.e.: Au = 120 cm² = PL 30/400 mm).

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IPE	-	180	200	220	240	270	300	330
h [mm]		180	200	220	240	270	300	330
g [kg/m]		18.8	22.4	26.2	30.7	36.1	42.2	49.1
Vpl,Rd [kN]		231	287	326	392	454	526	631
Au [cm2]	cv [cm]	Total effective width b_{eff} = 2.50 m Plastic moment resistance $M_{pl,Rd}$ [kNm]						
0	10	153	190	232	283	352	435	531
	12	170	210	256	311	385	473	575
	15	196	241	291	352	434	530	642
	20	238	291	351	422	515	626	753
	25	281	342	410	491	597	721	864
20	10	335	384	437	499	585	684	797
	12	366	418	475	541	632	737	855
	15	413	470	532	604	702	815	943
	20	491	556	627	708	819	946	1,090
	25	569	642	721	813	936	1,077	1,237
40	10	513	573	638	710	813	929	1,058
	12	558	622	690	766	874	996	1,131
	15	626	694	768	850	966	1,096	1,240
	20	740	816	898	991	1,118	1,262	1,422
	25	853	938	1,028	1,131	1,271	1,429	1,604
IPE	-	180	200	220	240	270	300	330

IPE	-	360	400	450	500	550	600
h [mm]		360	400	450	500	550	600
g [kg/m]		57.1	66.3	77.6	90.7	106.0	122.0
Vpl,Rd [kN]		720	875	1,042	1,227	1,483	1,717
Au [cm2]	cv [cm]	Total effective width b_{eff} = 4.00 m Plastic moment resistance $M_{pl,Rd}$ [kNm]					
0	10	674	833	1,050	1,312	1,622	1,990
	12	726	893	1,120	1,394	1,717	2,100
	15	803	983	1,225	1,517	1,861	2,266
	20	932	1,133	1,400	1,722	2,099	2,543
	25	1,061	1,283	1,576	1,927	2,338	2,820
20	10	973	1,157	1,403	1,695	2,034	2,429
	12	1,039	1,231	1,488	1,791	2,143	2,553
	15	1,138	1,342	1,614	1,935	2,308	2,741
	20	1,303	1,528	1,825	2,176	2,582	3,053
	25	1,467	1,713	2,036	2,416	2,856	3,366
40	10	1,273	1,480	1,757	2,077	2,445	2,867
	12	1,353	1,569	1,855	2,188	2,569	3,006
	15	1,473	1,701	2,003	2,353	2,754	3,215
	20	1,673	1,922	2,250	2,630	3,064	3,563
	25	1,873	2,143	2,496	2,906	3,373	3,911
60	10	1,561	1,792	2,099	2,449	2,845	3,299
	12	1,655	1,895	2,212	2,574	2,983	3,448
	15	1,796	2,049	2,381	2,761	3,190	3,678
	20	2,032	2,305	2,663	3,072	3,535	4,062
	25	2,268	2,562	2,945	3,384	3,880	4,445
80	10	1,842	2,097	2,434	2,814	3,241	3,728
	12	1,950	2,214	2,561	2,952	3,390	3,883
	15	2,113	2,389	2,752	3,161	3,618	4,134
	20	2,384	2,681	3,069	3,508	3,999	4,553
	25	2,655	2,973	3,386	3,855	4,380	4,972
IPE	-	360	400	450	500	550	600

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