Hot State Stud Calculations to BS & EC

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Director
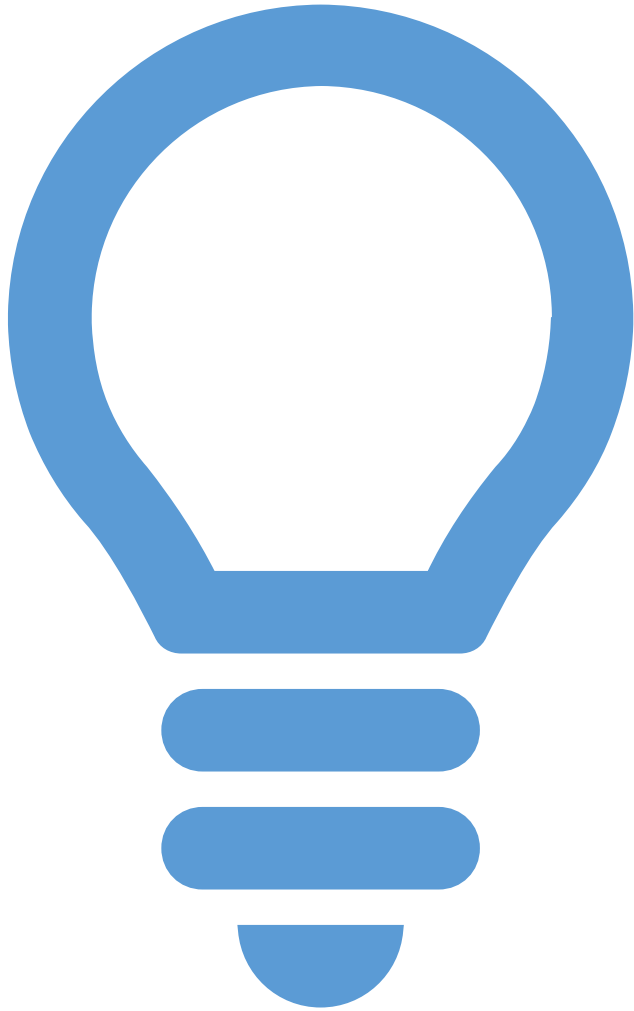
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What & Why?

- Lack of load capacity in test rigs
- Existing standards to **calculate** member capacity
- Time for heat transfer requires testing

Test Rig Capacity

UAE Test Rig				Concrete Floor	
Test Panel Width (m)	**Stud C (m)**	**Studs/Panel**		Roof Dead	3.3
3	0.6	5		Roof imposed	1.2
				Floor Dead	6.6
	kN (rig max loading)			Floor Imposed	4.4
	196	**kN/stud**		No Floors	1
kN/m	65	13.067		Load/m	15.50
				Stud C	0.6
				Estimated Load/Stud (kN/Stud)	9.30
				kN Remaining/Stud	3.77
				Remaining Capacity/Stud	28.83%

BRE - Oct 2022				Concrete Floor	
Test Panel Width (m)	**Stud C (m)**	**Studs/Panel**		Roof Dead	3.3
3	0.6	5		Roof imposed	1.2
				Floor Dead	6.6
	kN (rig max loading)			Floor Imposed	4.4
	150	**kN/stud**		No Floors	1
kN/m	50	10.000		Load/m	15.50
				Stud C	0.6
				Estimated Load/Stud (kN/Stud)	9.30
				kN Remaining/Stud	0.70
				Remaining Capacity/Stud	7.00%

Efectis - Netherlands				Concrete Floor	
Test Panel Width (m)	**Stud C (m)**	**Studs/Panel**		Roof Dead	3.3
3	0.6	5		Roof imposed	1.2
				Floor Dead	6.6
	kN (rig max loading)			Floor Imposed	4.4
	280	**kN/stud**		No Floors	2
kN/m	93	18.667		Load/m	26.50
				Stud C	0.6
				Estimated Load/Stud (kN/Stud)	15.90
				kN Remaining/Stud	2.77
				Remaining Capacity/Stud	14.82%

- *EN 1365-1 clause 13 which states that we cannot increase the design load from that tested*
- *Test rig had a load capacity of 135kN overall*
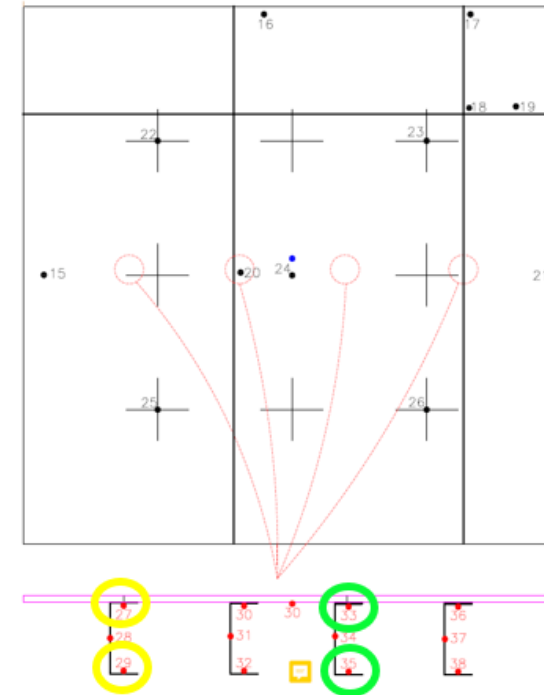- *Equates to 45kN/m - (300mm centres effectively)*

Existing Standards

- *BS 5950-8, Annex A*

- *BS EN 1993-1-2, Cl 4.2.4 Critical Temperature, Table E.1*

- *Section properties using **ambient** temperature properties*

- *System Build Up – NOT stud only*

- *Unlimited loads, heights, spacings, profiles.*
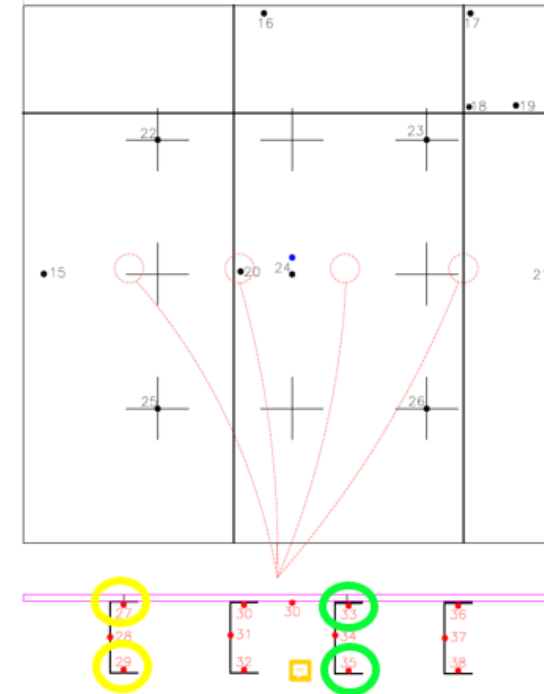
Required Information

- *Hot Flange temperature and time*

- *Board / system build up – NOT stud ONLY*

- *Section properties using **ambient** temperature properties*

- *BOTH codes assume stud immediately reaches temperature across stud and do not account for temperature induced bending*

Cha 27	Cha 28	Cha 29	Cha 30	Cha 31	Cha 32	Cha 33	Cha 34	Cha 35	Cha 36	Cha 37	Cha 38
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
537	517	454	742	538	573	516	510	566	440	547	510
544	527	465	750	552	587	526	520	574	446	554	519
553	537	475	760	569	604	544	538	583	451	561	527
560	547	486	765	586	618	558	554	593	457	570	536
568	557	496	770	602	633	570	568	605	463	578	544
578	568	507	773	618	646	584	578	614	594	589	555

Temperatures

- *Hot Flange temperature and time*

- *Board / system build up – NOT stud ONLY*

- *Section properties using **ambient** temperature properties*

- *BOTH codes assume stud immediately reaches temperature across stud and do not account for temperature induced bending*

Cha 27	Cha 28	Cha 29	Cha 30	Cha 31	Cha 32	Cha 33	Cha 34	Cha 35	Cha 36	Cha 37	Cha 38
°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
537	517	454	742	538	573	516	510	566	440	547	510
544	527	465	750	552	587	526	520	574	446	554	519
553	537	475	760	569	604	544	538	583	451	561	527
560	547	486	765	586	618	558	554	593	457	570	536
568	557	496	770	602	633	570	568	605	463	578	544
578	568	507	773	618	646	584	578	614	594	589	555

Heat across Studs

- *Standards don't reflect differential bending due to temperature induced stresses*

- *Calculations and standards don't **explicitly** account for board cracking under load / heat*

- *Testing for heat with stud with smallest possible CSA produces worst fire rating / time*
  - *Thicker stud draws more heat through which reduces latent heat to release moisture from board(s)*
  - *Stud temperatures don't rise causing heat induced buckling 'till heat passes through boards (**obvious, but**).*

- *Axial Load causes twisting, bowing and buckling before heat*

- *Rigs can't apply sufficient load to buckle so testing can't re create*

Counter Points

- *Ambient checks produce differing results to both standards*
  - *and testing*
- *Both ambient and hot state are based on **declared** yield strengths*
- *Does NOT need board manufacture buy in – data can come from anywhere*
- *Testing will be more accurate – **upto load capacity of rig only***
- ***Testing is always more accurate than calculation – to a point***

Can be used as part of a wider 'system' methodology including:

- *Racking*
- *Noggins*
- *Acoustics*
- *Robustness*
- *And not forgetting, Fire*

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