QUALITY AND SAFETY IN PRECAST CONSTRUCTION

Presentation by : **Er. K KRISHNA MURTHY,**
B.E (Hons.), M. Tech, F.I.E., F.I.V.
HYDERABAD, PH: 9866121998

Email: kmkompella1@gmail.com

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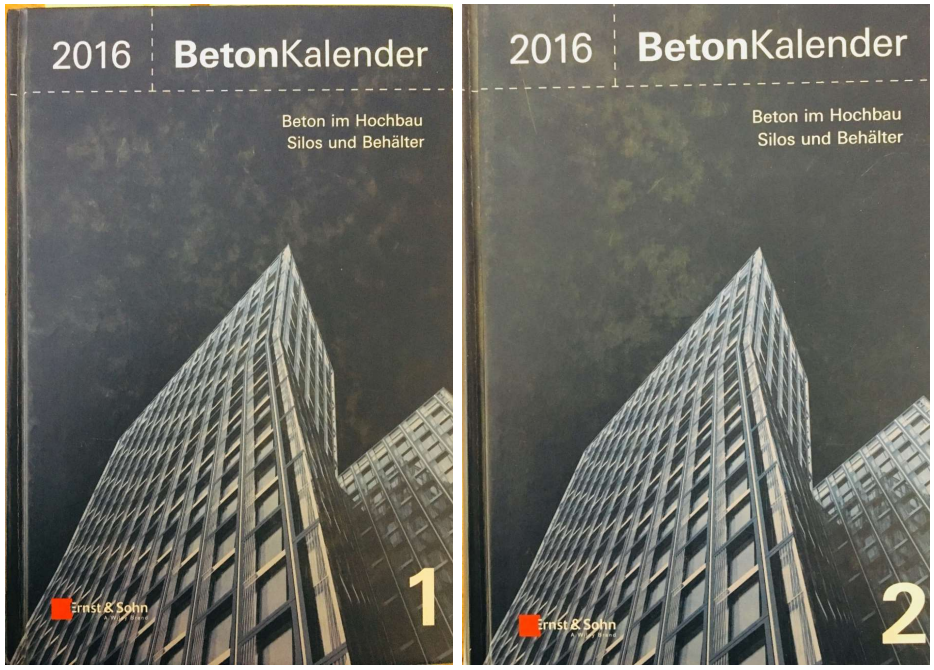
REFERENCES

1. **IS:456**, CODE OF PRACTICE FOR PLAIN AND REINFORCED CONCRETE.
2. **IS:875**, CODE OF PRACTICE FOR DESIGN LOADS (OTHER THAN EARTHQUAKE) FOR BUILDINGS AND STRUCTURE **(PART-2)**.
3. **IS:1893**, CODE OF PRACTICE FOR EARTHQUAKE FOR ALL BUILDING STRUCTURES **(PART-1)**.
4. **IS:13920**, DUCTILE DETAILING AND REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES.

BETON KALENDER 2016, VOLUMES-1&2 (GERMAN)



STRUCTURAL SYSTEMS AND METHOD OF CONSTRUCTION

- STRUCTURAL SYSTEMS AND METHOD OF CONSTRUCTION ARE CHOOSEN, BASED ON
    - LOCATION AND SITE CONDITIONS.
    - AVAILABILITY OF MATERIALS AND MANPOWER
    - INFRASTRUCTURE
    - QUALITY AND SAFETY
    - TIME AND COST

PRE-CAST CONSTRUCTION

- PRE-CAST CONSTRUCTION OFFERS SOLUTION TO ALL THE ABOVE REQUIREMENTS AND PROBLEMS.
  - ✓ REDUCING MATERIAL CONSUMPTION BY OPTIMISATION OF ELEMENTS INDIVIDUALLY.
  - ✓ USING MATERIALS OF HIGH QUALITY FOR STRENGTH AND DURABILITY.
  - ✓ REDUCING MANPOWER AND ENHANCING SAFETY.
  - ✓ REDUCING CONSTRUCTION TIME FECILITATING EARLY USE.

PRE-CAST CONSTRUCTION (Contd;)

- REDUCTION IN TIME SUBSTANTIALLY INFLUENCES COST OF INVESTMENT, EARLY USAGE AND RETURNS, COST ESCALATIONS DUE TO DELAYS etc.,.

- UNFORTUNATELY, THE ABOVE FACT IS NOT PROPERLY ACCOUNTED FOR IN COST COMPARISON OF PRECAST Vs IN-SITU CONCRETE WORKS.

1. STRUCTURAL SYSTEMS

- STRUCTURAL SYSTEMS ARE MOSTLY **STATICALLY DETERMINATE** FOR ANALYSIS AND DESIGN OF ELEMENTS i.e., SLABS, BEAMS etc.,.
- OFFER EASE IN DESIGN, WITHOUT THE INFLUENCE OF
  - MOMENTS DUE TO CONTINUITY
  - SECONDARY EFFECTS DUE TO TEMPERATURE, CREEP.
- ALL MEMBERS SHALL INDIVIDUALLY HAVE STRENGTH, STABILITY, RIGIDITY AND REQUIRED DEGREE OF CRACK RESISTANCE.

1. STRUCTURAL SYSTEMS (Contd;)

- STRUCTURES SHALL HAVE OVERALL STRENGTH AND SKELITAL RIGIDITY i.e., ABILITY TO RESIST HORIZONTAL FORCES DUE TO WIND/EARTHQUAKE.
- ALL ELEMENTS ARE DETAILED, CAST IN ACCURATELY FORMED MOULDS, CURED IN TEMPERATURE CONTROLLED CHAMBERS, TRANSPORTED AND ERECTED AT SITE.

2. CLEARANCES AND TOLERANCES

- CLEARANCES FOR ERECTION AND SEATING OF MEMBERS IN THEIR FINAL POSITION IN THE STRUCTURE SHALL BE SHOWN IN THE DRAWINGS FOR ALL ELEMENTS.
- MEMBERS SHALL BE CAST TO LENGTHS AS SPECIFIED (**STRUCTURAL LENGTHS**).
- ERRORS IN CASTING(**AS CAST LENGTH**), SEATING IN POSITION, ALIGNMENT CANNOT BE CORRECTED AT SITE.

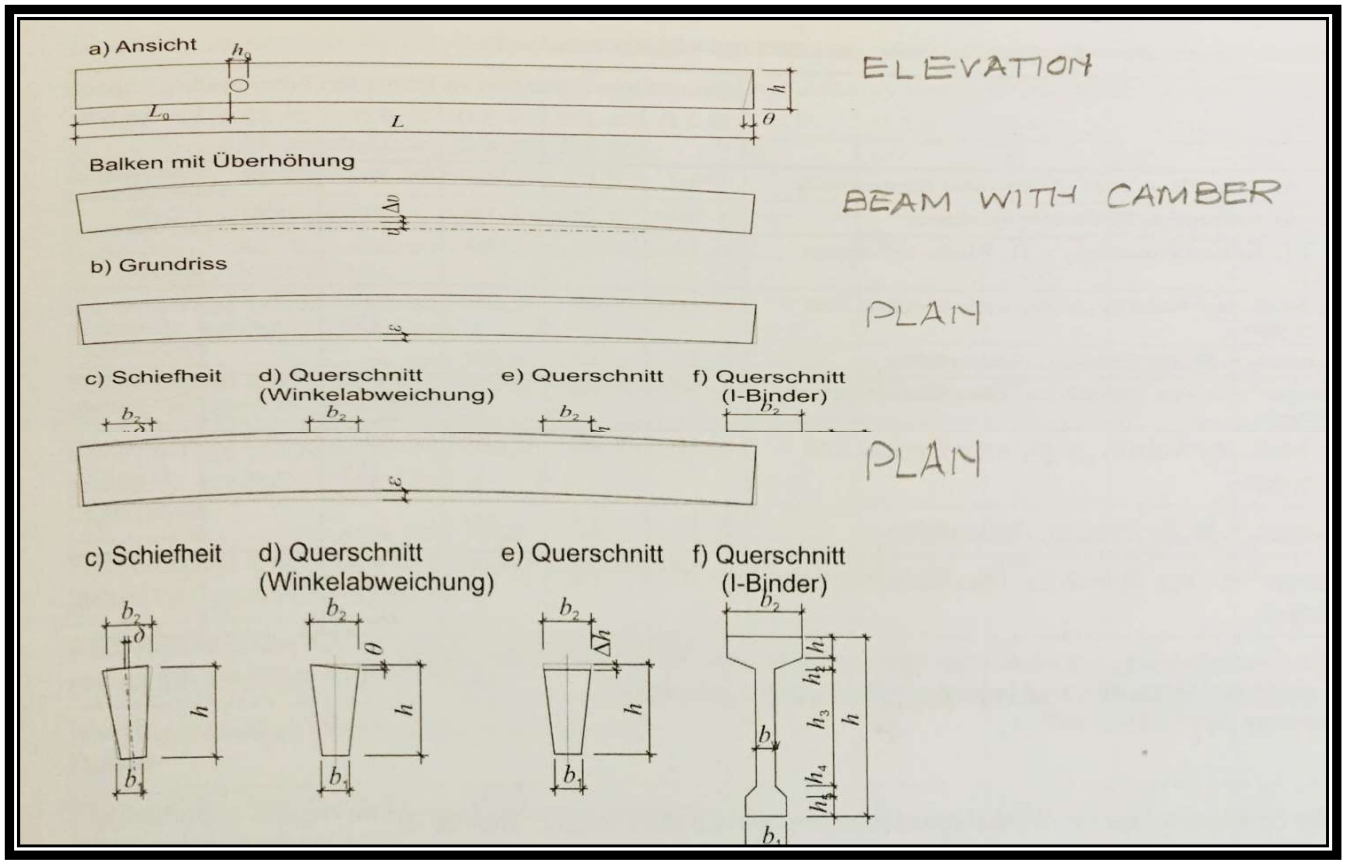
2. CLEARANCES AND TOLERANCES (Contd;)

- THE DIFFERENCE BETWEEN STRUCTURAL (AS SPECIFIED) AND AS CAST LENGTH IS **'VARIATION'**.
- THE VARIATIONS ARE ACCOMODATED IN THE FORM OF CLEARANCES, LIMITED BY TOLERANCES, LEAVING JOINTS WHICH WILL BE FILLED WITH SUITABLE SEALANTS.
- SEALANTS SHALL ACCOMMODATE STRAIN AT JOINTS TO AN EXTENT OF $\pm$25% MINIMUM.

PERMISSIBLE TOLERANCES

(DIN 18203)

TOLERANCE LIMITS PRESCRIBED FOR ELEMENTS IN LENGTH, CROSS SECTION, ANGULAR TWIST, EDGE SLOPE etc., ARE SHOWN IN THE TABLE



(SOURCE: BETON KALENDER 2016 VOL-1 (GERMAN), PAGE 261)

Grenzabweichungen der Längenmaße

TOLERANCES IN LENGTH : BEAMS

Bauteil	Grenzabweichungen ΔL in [mm] bei Nennmaßen L in [m]							
	≤ 1,5	> 1,5 ≤ 3,0	> 3,0 ≤ 6,0	> 6,0 ≤ 10,0	> 10,0 ≤ 15,0	> 15,0 ≤ 22,0	> 22,0 ≤ 30,0	> 30,0
Längen Stahlbetonbalken (RCC)	± 6	± 8	± 10	± 12	± 14	± 16	± 18	± 20
Längen Spannbetonbalken (PT)	-	-	-	± 16	± 16	± 20	± 25	± 30

LENGTH FROM 1.5 TO 30m

TOLERANCE ± 6 TO ± 20mm FOR RCC

Grenzabweichungen der Querschnittsmaße

TOLERANCES IN DEPTH AND WIDTH

Bauteil	Grenzabweichungen Δh, Δb in [mm] bei Nennmaßen h, b in [m]					
	≤ 0,15	> 0,15 ≤ 0,30	> 0,30 ≤ 0,60	> 0,60 ≤ 1,0	> 1,0 ≤ 1,5	≥ 1,5
Querschnittsmaße Balken	± 6	± 6	± 8	± 12	± 16	± 20

FOR h or b = 0.15 TO 1.5m

TOLERANCE ± 6 TO ± 20mm

Grenzwerte für Winkelabweichungen

TOLERANCE ON ANGULAR DEVIATION

Bauteil	Grenzwerte für Winkelabweichungen θ in [mm] bei Nennmaßen in [m]		
	≤ 0,40	> 0,40 ≤ 1,0	≤ 1,50
Querschnittsmaße Balken	± 4	± 6	± 8

Durch Ausnutzen der Grenzabweich… der Längen- oder Querschnittsmaß… die Grenzwerte für Winkelabweichu… nicht überschritten werden. Es gilt … jeweils strengere Kriterium.

FOR h = 0.4 TO 1.5m

TOLERANCE OF θ ± 4 TO ± 8mm

Sonstige Grenzwerte

Grenzwert für die Krümmung ε in jeder Hautebene: $\varepsilon = \pm L/700$
Grenzwerte für Abweichungen von der Überhöhung $\Delta v = \pm L/700$ (Bei Spannbetonbalken: $\Delta v = \pm L/500$)
Schiefheit der Längsachse: $\delta = \pm L/700$
Grenzabweichungen für Öffnungen: - Lage der Öffnung: ΔL_o wie ΔL (Länge) - Größe der Öffnung: Δh_o nach Tabellen A.1 und A.2

TOLERANCE IN BEAMS

Bild 7. Grenzabweichungen für Balken nach DIN 18203-1 und DIN EN 13225

TOTAL CONSTRUCTION TOLERANCE

- INDIVIDUAL LIMITS OF TOLERANCES IN THE STRUCTURE, EVEN IF MAINTAINED MAY NOT RESULT IN AN ACCEPTABLE OVERALL LENGTH OF STRUCTURE.
- SUCH LENGTHS SHALL BE MEASURED AND APPROVED AT SITE.

  Ex: OVERALL LENGTH OF BUILDING FACADE etc.,
- FOR APPROVAL, THE INDIVIDUAL DEVIATIONS AS WELL AS THE OVERALL DEVIATION SHALL BE COMPARED WITH THE LIMITS SPECIFIED AND THE JOINT WIDTHS DECIDED THEREON.

3. INDIVIDUAL ELEMENTS: DESIGN CONSIDERATIONS

MATERIAL STRENGTH REDUCTION FACTOR

- IS:456 SPECIFIES A REDUCTION FACTOR OF **1.5** TO ACCOUNT FOR THE VARIATION IN MATERIAL STRENGTH, WHICH IS SIGNIFICANTLY HIGH IN IN-SITU CONCRETE.
- BEACAUSE OF CONTINUOUS CONTROL ON WORKS, USE OF QUALITY MATERIALS AND FREQUENT TESTING, THE FACTOR MAY BETAKEN AS **1.35** AS PER STANDARD DIN EN 1992-1-1/NA (GERMAN)

3. INDIVIDUAL ELEMENTS: DESIGN CONSIDERATIONS (Contd;)

- THE REDUCTION TO 1.35 MAY BE USED IN SLABS RESTING ON BEAMS, AS SLABS ARE SUBJECTED TO GRAVITY LOADS ONLY. HOWEVER, A CHECK ON CRACK WIDTH IS NECESSARY.
- FOR BEAMS AND COLUMNS IN A FRAME, THIS REDUCTION MAY BE CONSIDERED AS RESERVE ONLY.
- DESIGN LIVE LOADS ON SLABS FOR RESIDENTIAL BUILDINGS

IS:875	
ALL SLABS EXCEPT FOR CORRIDOR AND BALCONY SLABS	2 kN/m^2
EURO AND DIN STANDARDS	
SLABS WITH ADEQUATE LATERAL LOAD DISTRIBUTION	1.5 kN/m^2
SLABS NOT HAVING ABOVE	2 kN/m^2

SLABS- TYPES

4. SLABS - TYPES

HOLLOW CORED SLABS: (PT)

- ONE-WAY IN ACTION, WITH A WIDTH UPTO 1.2m.
- WEIGHT REDUCTION UPTO 50% OF SOLID SLAB FOR SAME SPAN AND LOAD REQUIREMENTS.
- CUTOUTS IF ANY, SHALL BE PROVIDED WHILE CASTING.
- SMALL MODIFICATIONS IN THE CORE ONLY.
- LARGE CUT-OUT REQUIREMENTS SHALL BE MET THROUGH STRUCTURAL STEEL, SUITABLY CONNECTED.
- ECCENTRIC PRESTRESSING CAUSES UPWARD DEFLECTION.
- EXCESS OVER CALCULATED DEFLECTION LIMITED TO $\pm \frac{L}{1000}$

4. SLABS - TYPES (Contd;)

LATTICED TYPE SLABS:

- THESE ARE SLABS WITH PRECAST PART CONTAINING MAIN STEEL WITH LATTICED TYPE REINFORCEMENT, WHICH ON PLACING IN POSITION COVERED WITH IN-SITU CONCRETE.
- CAN BE USED UPTO A SPAN OF 4 TO 5m WITHOUT PROPPING.
- NORMALLY ONE-WAY, CAN BE MADE TWO-WAY BY INTRODUCING TRANSVERSE STEEL OVER PRECAST PART AS PER DESIGN BEFORE IN-SITU CONCRETING.
- LIGHTER FOR TRANSPORT. WEIGHS ~ 200kgs FOR A SIZE OF 0.4m x 4.0m x 50mm Thk.,.
- CAN BE USED AS OUTSIDE PARTS OF A WALL WITH IN-SITU FILLING INSIDE.

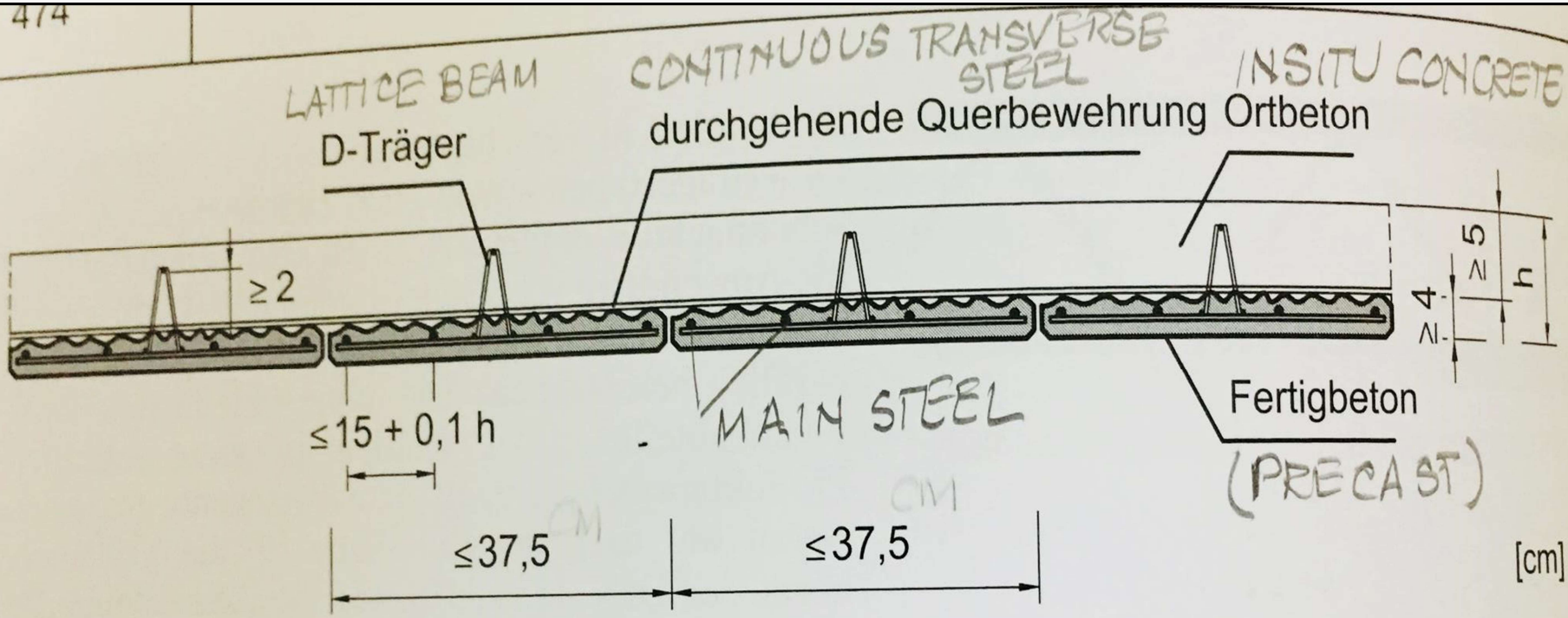


Bild 8. Streifenelemente mit Gitterträgern aus [17]

LATICED TYPE SLABS

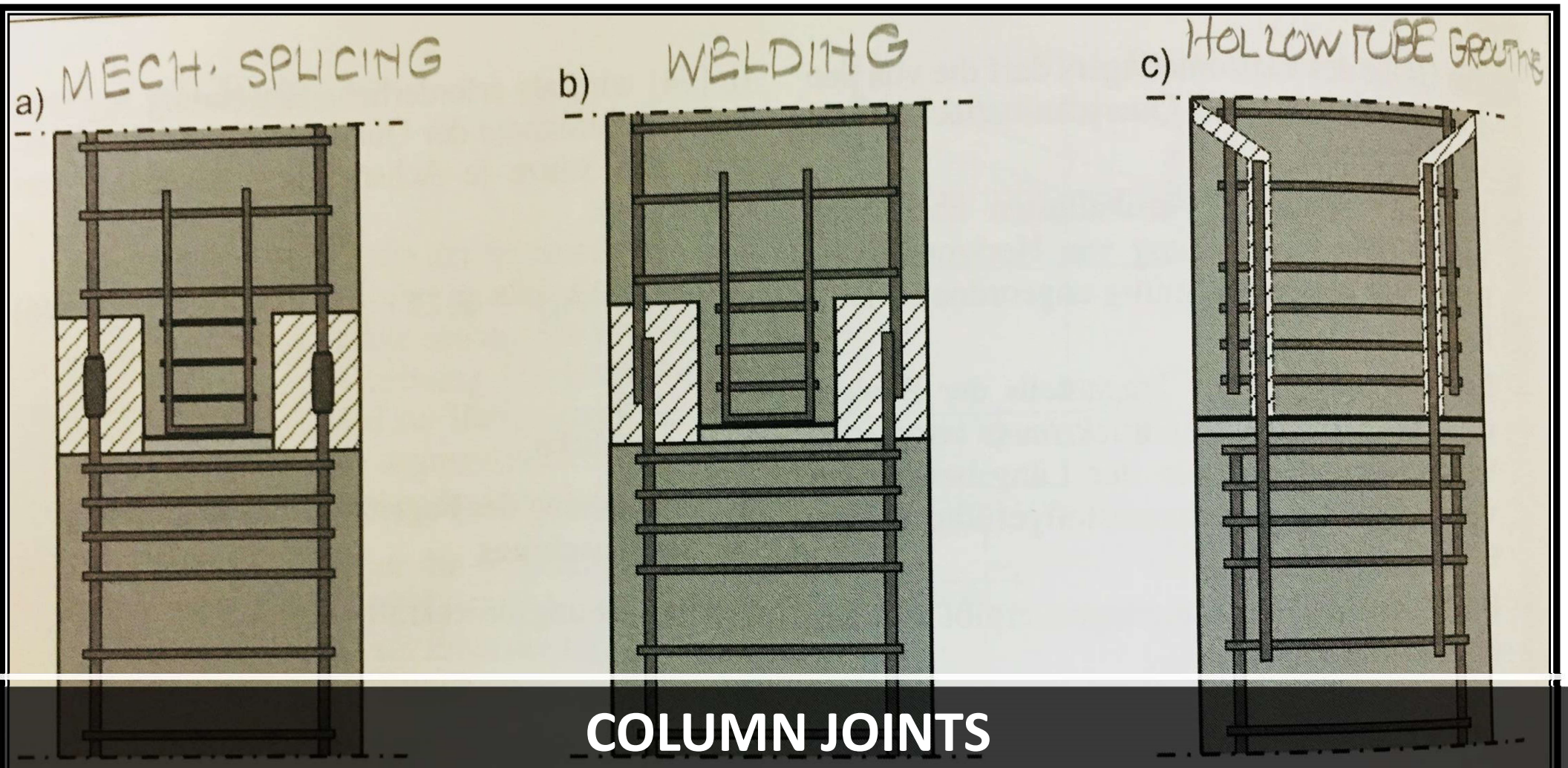
Bild 2. Gitterträger (Standardgitterträger)

LATTICED TYPE SLABS

5. JOINTS FOR CONTINUITY

COLUMNS:

- MOMENT TRANSFER CONNECTIONS IN COLUMNS MAY BE DONE THROUGH:
  - ✓ MECHANICAL SPLICING
  - ✓ WELDING
  - ✓ LAPPING THROUGH HOLLOW TUBES AND GROUTING



COLUMN JOINTS

Bild 114. Biegesteife Stützenstöße mit a) Mörtelmuffenstoß nach [84], b) Schweißverbindungen, c) Übergreifungsstößen in Hüllrohren

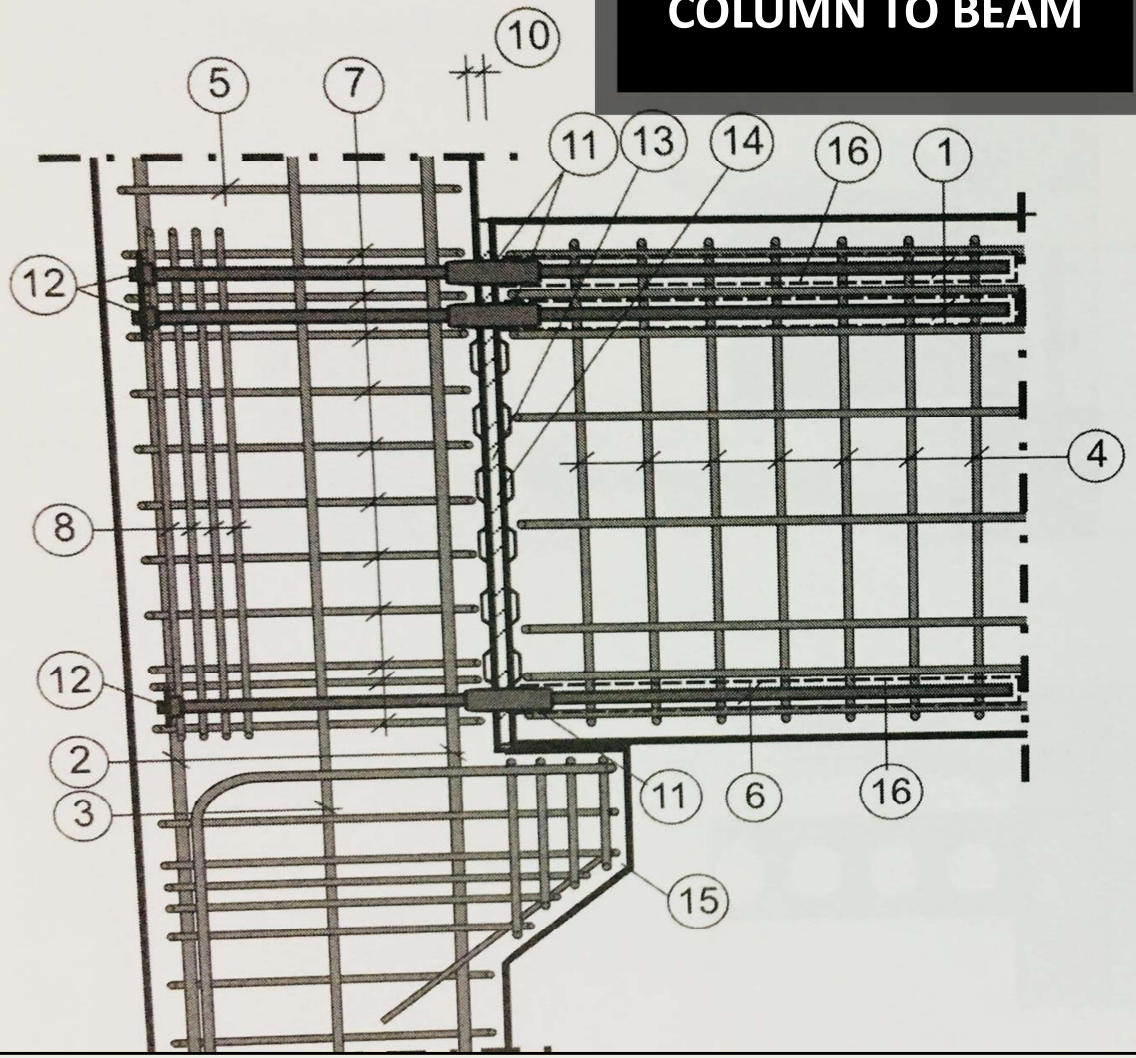
5. JOINTS FOR CONTINUITY (Contd;)

COLUMN TO BEAM:

- CONNECTION THROUGH THREADED BARS (USUAL PRACTICE)

  IN DETAIL

COLUMN TO BEAM



1. TOP STEEL FOE BENDING, THREADED
2. COLUMN BARS
3. COLUMN BARS
4. SHEAR RINGS IN BEAM
5. COLUMN RINGS
6. BOTTOM THREADED BARS FROM BEAM
7. RINGS IN JUNCTION
8. VERTICAL RINGS IN BEAM BAR ANCHOR ZONE.
10. JOINT ≥ 20mm.
11. COUPLERS
12. ANCHOR PIECE FOR COUPLER
13. ROUGH, TOOTHED JOINT
14. MORTAR FILL
15. BRACKET

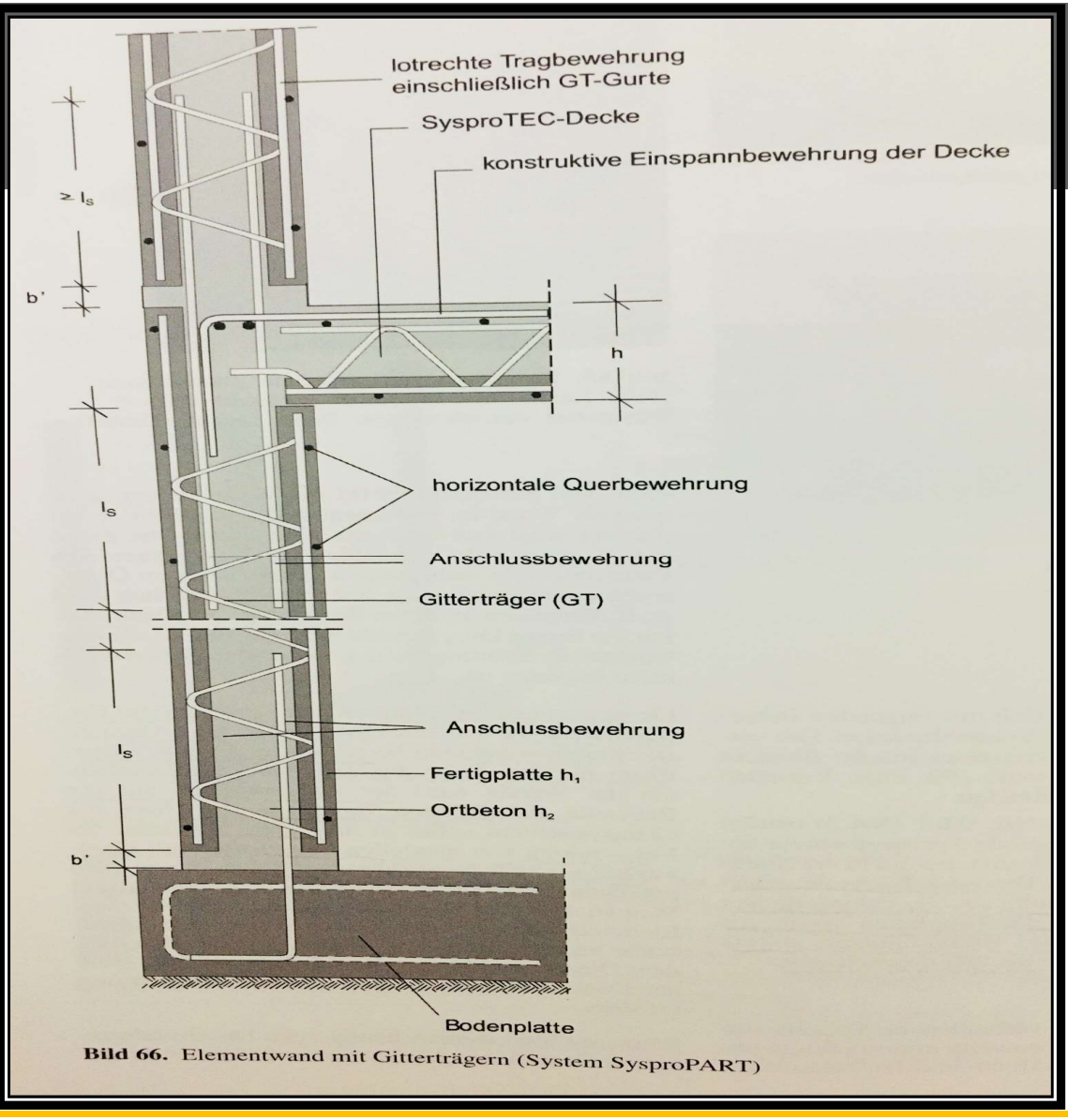


Bild 66. Elementwand mit Gitterträgern (System SysproPART)

5. JOINTS FOR CONTINUITY
(Contd;)

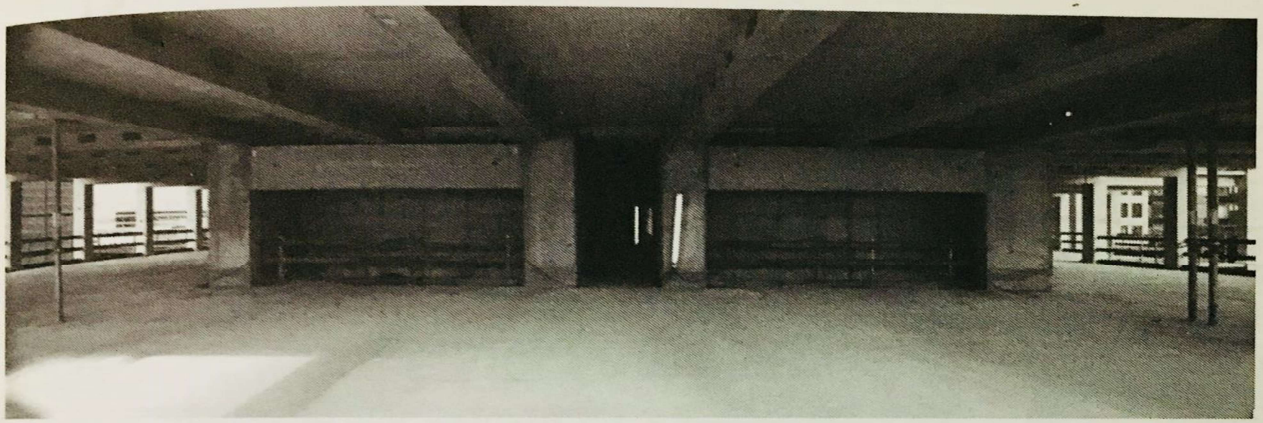
WALLS:

NORMAL THICKNESS	140 - 200mm
OUTER PRECAST ELEMENT	40 - 60mm (LATTICED SLAB)
INNER CORE IN-SITU CONCRETE	70mm (SELF COMPACTING)
	100mm (NORMAL)

6. PRECAST COLUMNS AND BEAMS WITH IN-SITU WALL

- IN CERTAIN CONSTRUCTIONS, IT MAY BE ADVANTAGEOUS TO BUILD THE WALLS IN-SITU AND CONNECT THE BEAMS BY SEATING ON STEEL BRACKETS ON ONE SIDE AND ON PRECAST COLUMN BRACKET ON OTHER SIDE.

IN-SITU WALL



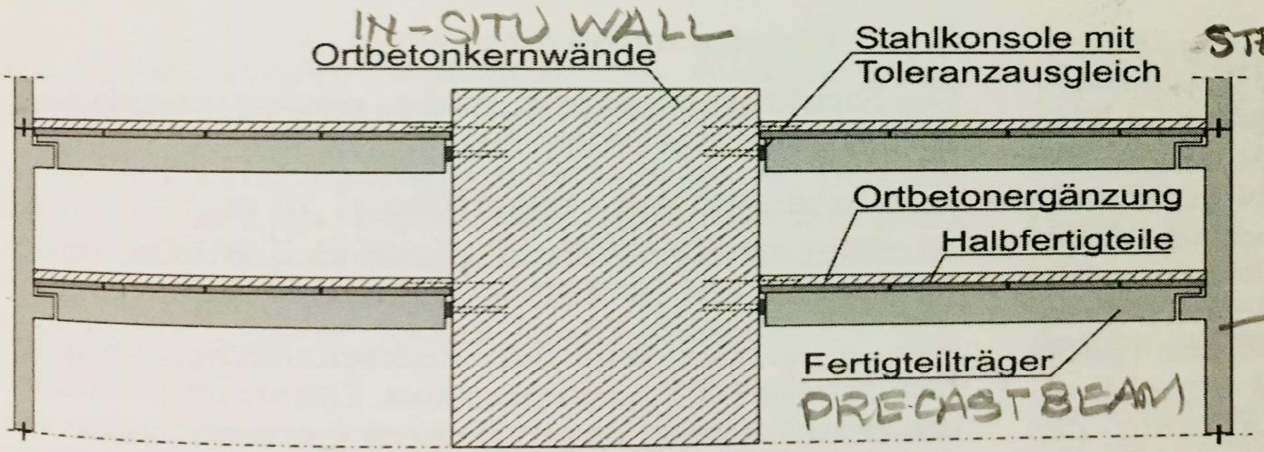


Bild 25. Querschnitt der FT-Konstruktion beim Hochhaus Taunusturm Frankfurt a. M. (Ausführung: Ed. Züblin AG)

6. PRECAST COLUMNS AND BEAMS WITH IN-SITU WALL
(Contd;)

- SIMILARLY, PRECAST FLIGHTS OF STAIRS MAY BE CONNECTED TO IN-SITU LANDINGS.

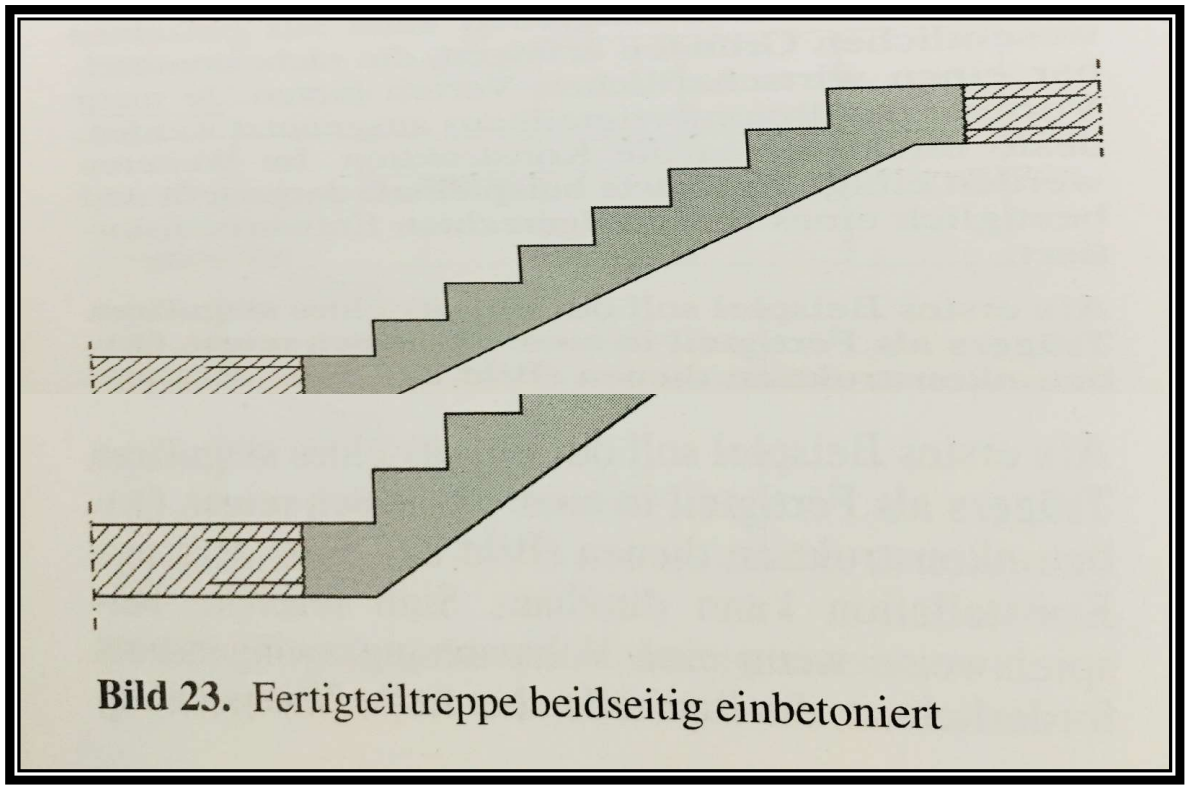


Bild 23. Fertigteiltreppe beidseitig einbetoniert

7. CONCRETE FOR PRECAST WORKS

FRESH CONCRETE:

- APART FROM STRENGTH REQUIREMENT, CONCRETE SHALL FLOW AND FILL IN THE FORMS EASILY.
- DURING COMPACTION, COARESE AGGREGATE PARTICLES TRAVEL TWORDS BOTTOM AND FINER PARTICLES STAY ON TOP OF THE MEMBER, RESULTING IN SHRINKAGE OF TOP LAYERS.
- THE MIXING WATER, BEING THE LIGHTEST OF ALL COMPONENTS IN CONCRETE SHALL NOT FORM A LAYER CAUSING **BLEEDING**.

7. CONCRETE FOR PRECAST WORKS (Contd;)

- USE OF FAST SETTING CEMENTS, ADMIXTURES LIKE FLYASH, SILICA FUME, REDUCED w/c RATIO, IS NECESSARY AS PER MIX DESIGN.
- SILICA FUME IMPROVES THE STRENGTH UPTO 20% BUT RESULTS IN **EARLY HIGH SHRINKAGE**.

HARDENED CONCRETE:

- THE **EARLY** STRENGTH SHALL BE HIGH, TO FACILITATE DESHUTTERING AT THE PLANNED HOUR FOR THE NORMALLY USED CONCRETE GRADES M35 & M45.
- FOR PRESTRESSED WORKS, A MINIMUM STRENGTH OF 25N/mm^2 IS REQUIRED.

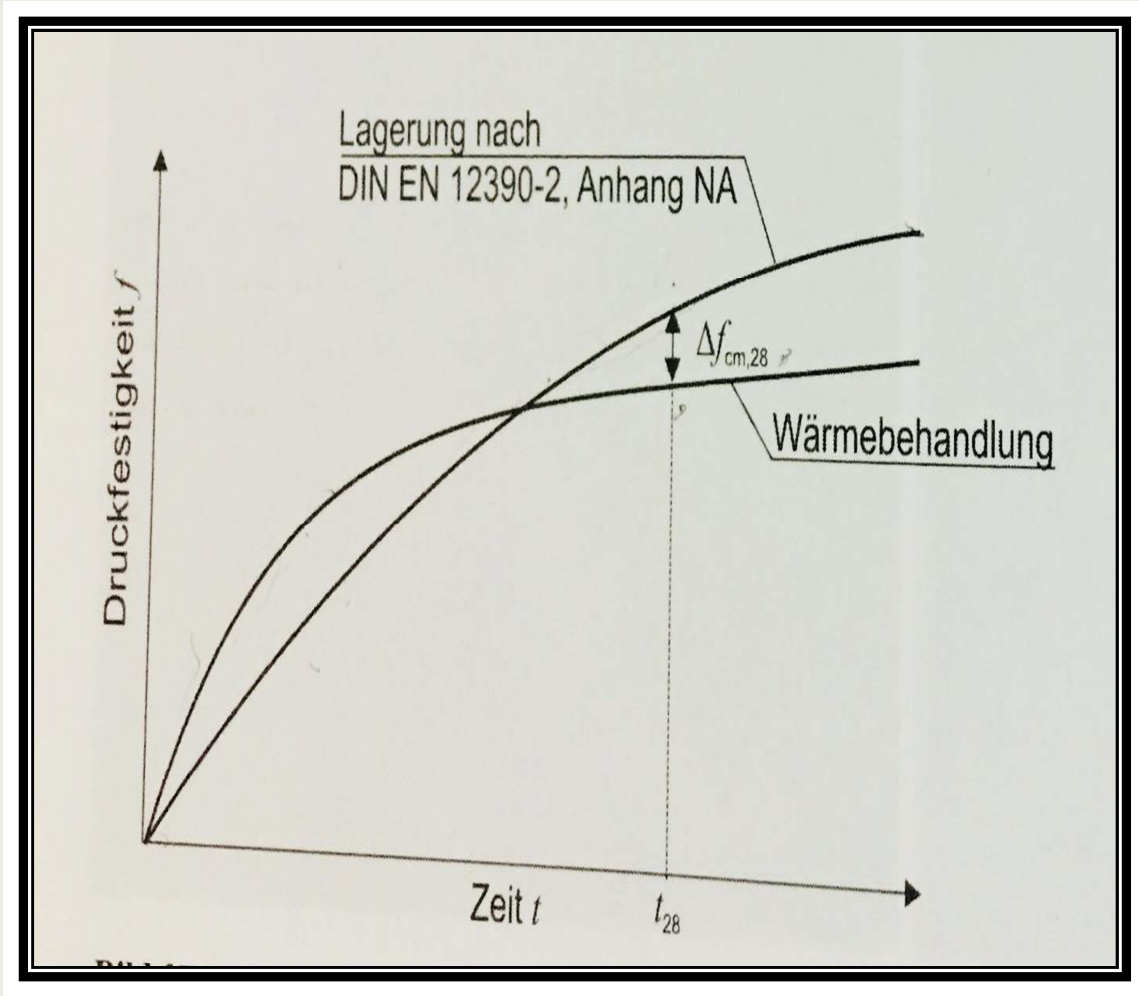
CURING UNDER HIGH TEMPERATURE

- TO REDUCE THE TIME OF HARDENING OF CONCRETE FOR EARLY DESHUTTERING, CURING IS DONE AT INCREASED TEMPERATURE LEVELS (UPTO 80°C) THROUGH
  - ✓ STEAM OR HOT AIR
  - ✓ ELECTRICAL HEATING OR INFRARED RAYS
- UNDER THE ARTIFICAL METHOD OF HIGH TEMPERATURE CURING HIGH VOLUME OF CHEMICAL COMPONENTS IN CEMENT REACT FAST AND CONTRIBUTE FOR EARLY STRENGTH, LEAVING LESS VOLUME FOR STRENGTH GAIN LATER.

CURING UNDER HIGH TEMPERATURE (Contd;)

- THUS, CONCRETE UNDER HIGH TEMPERATURE CURING IS LIKELY TO DEVELOP LESS STRENGTH AT 28 DAYS COMPARED TO CONCRETE UNDER NORMAL CURING CONDITIONS.

- HIGH TEMPERATURE CURING MAY CAUSE LOSS OF PRESTRESS ~ 4% TO BE COMPENSATED BY OVER STRESSING.



8. REINFORCEMENT DETAILING

- REINFORCEMENT WORK COSTS ~ 30% OF TOTAL COST OF PRECAST PRODUCT. HENCE, AN ECONOMICAL STEEL LAYOUT AND ADEQUATE COVER PROVISION ARE ABSOLUTELY NECESSARY.
- ALL STEEL BARS, RINGS AND MATS SHALL BE PROPERLY CHECKED FOR DIAMETER, SPACING, QUALITY WEIDING etc., AND CERTIFIED.
- VARIATION IN AREA OF BARS SHALL BE SUITABLY COMPENSATED.
- PERMISSABLE VARIATION IS +6% AND -4% (DIN STANDARDS).

8. REINFORCEMENT DETAILING (Contd;)

- WHEREEVER STEEL ARRANGEMENT IS COMPLICATED (LIKE BRACKETS) STEEL BARS SHALL BE SHOWN IN DOUBLE LINES WITH STANDARD BENDS TO AN ENLARGED SCALE.
- BAR DIAMETER SHALL BE INCREASED BY 20% ATO ACCOMMODATE SPACING REQUIREMENTS, ALLOWING FOR RIBS.

DRAWING TO INCLUDE ESSENTIAL INFORMATION

- APART FROM GENERAL NOTES INCLUDED IN THE DRAWINGS FOR CAST-IN PLACE CONCRETE WORKS, THE FOLLOWING SHALL BE INCLUDED FOR ALL PRE-CAST ELEMENTS, WHICH IS **MANDATORY**
  - CONCRETE GRADE VOLUME WEIGHT
    M40/45 m^3 t
  - EXPOSURE CLASS - MODERATE/SEVERE/EXTREME etc.,
  - FIRE RESISTANCE PERIOD - 0.5/1.0/1.5/2.0 hrs.
  - CLEAR COVER SLABS(TOP, BOTTOM)
  - PERMISSIBLE DEVIATION .....mm

DRAWING TO INCLUDE ESSENTIAL INFORMATION (Contd;)

- PARTIAL SAFETY FACTOR FOR MATERIAL - 1.5 OR ……
- STEEL GRADE - REINFORCEMENT ……CODE……

- PRECAST ELEMENT SURFACE FINISH (SHUTTERING SIDE AND EXPOSED TOP) STANDARD SYMBOLS SIMILAR TO WELDS SHALL BE USED.

  (MODEL DRAWING OF THE GERMAN PRE-CAST CONCRETE MANUFACTURER'S ASSOCIATION)

Biegen von Betonstählen nach DIN EN 1992-1-1 (EC 2)

Bei der Bestimmung des Mindestbiegerollendurchmessers D min ist EC 2, 8.3, Tabelle 8.1DE a)/b) zu beachten und nach der bautechnischen Funktion der Biegung zu unterscheiden.

A) Biegungen zur Kraftumleitung
(Schrägstäbe oder andere gebogene Stäbe)

Mindestwerte der Betondeckung rechtwinklig zur Krümmungsebene	Biegerollendurchmesser D [mm]
> 100 mm und > 7 ø	D min = 10 ø
> 50 mm und > 3 ø	D min = 15 ø
≤ 50 mm und ≤ 3 ø	D min = 20 ø

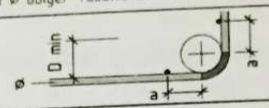
Biegungen nach A)
zur Herstellung und Überprüfung ist der **erforderliche Biegerollendurchmesser immer anzugeben** und zwar an der Biegeform im Bewehrungsplan und auf der Stabliste.

konstruktive Biegungen
(Haken, Winkelhaken, Schlaufen, Bügel)

Stabdurchmesser ø [mm]	Biegerollendurchmesser D [mm]
< 20	D min = 4 ø
≥ 20	D min = 7 ø

Biegungen nach B)
wird an der Biegeform weder im Bewehrungsplan noch auf der Stabliste ein Biegerollendurchmesser angegeben, so ist erf. D in Abhängigkeit von ø obiger Tabelle zu entnehmen.

Bei Betonstahlmatten und geschweißter Bewehrung, die nach dem Schweißen gebogen werden, ist zusätzlich EC 2, 8.3, **Tabelle 8.1DE b)** zu beachten.
Die unter A) und B) aufgeführten Mindestwerte der Biegerollendurchmesser gelten nur, wenn **a ≥ 4 ø** (a = Abstand der Schweißung vom Krümmungsbeginn).



Betonfestigkeitsklasse: **C35/45**	Volumen: **7,27 m³**
Expositionsklasse: **XC1, WO**	Gewicht: **18,175 t**
Vorhaltemaß: **△Cdev = 5 mm**	Feuerwiderstandsklasse: **R90**
Teilsicherheitsbeiwert Beton: **γ_c = 1,50**	Dreikantleiste: **1/1cm**

Betonstahl- und Spannstahlsorte:
Matten: **B500A**
Stabstahl: **B500A**
Spannstahl: **St 1570/1770 (Zulassung Z-12.3-4)**

Verlegemaße der Betondeckung:
Stege: **2,0 cm** Platte: **2,0 cm** unten Platte: **2,0 cm** oben

Fertigteil-oberflächen						
	Einfüllseite:	rauh	abgezogen	abgerieben	sauber glätten	Sonderschalung XX
	Schalseiten:	Sichtbeton glatt	o. Anforderungen	ST Struktur	WB Waschbeton	XX Sonderschalung

konstruktiv & kreativ

Musterzeichnung der Fachvereinigung

DICAD

Deutscher Betonfertigteilbau e. V. Bonn

Schloßallee 10 - 53179 Bonn - Fon 0228 955456-56
Fax 0228 955456-90

Bauherr: N. N.	Statische Pos. D.001-01
Bauvorhaben: Musterbau	Auftragsnummer:
Bauteil: Deckenplatte: TT-Profil	Maßstab: 1:25; 10; 5

Index	Änderung	Datum	Name

TYPICAL DRAWING WITH ESSENTIAL INFORMATION (Contd.,)

Besondere Anforderungen:

Nachbehandlung:

	Datum	Name
bearbeitet	März 2013	DICAD
geprüft	März 2013	FDB
Produktionsfreigabe		

Zeichnungs-Nr. D 01

9. PRECAST ELEMENTS – ERECTION TIME (AVERAGE)

ELEMENT	No. OF ELEMENTS/HOUR
ROOF BEAMS	1.5
PURLINS	3
TIE BEAMS	2.5
PT HOLLOW CORE OR LATTICE TYPE SLABS	6
DOUBLE T SLABS	2.5
COLUMNS	2 TO 2.5
WALLS	2
STAIR CASES	2

9. SAFETY AGAINST TILTING

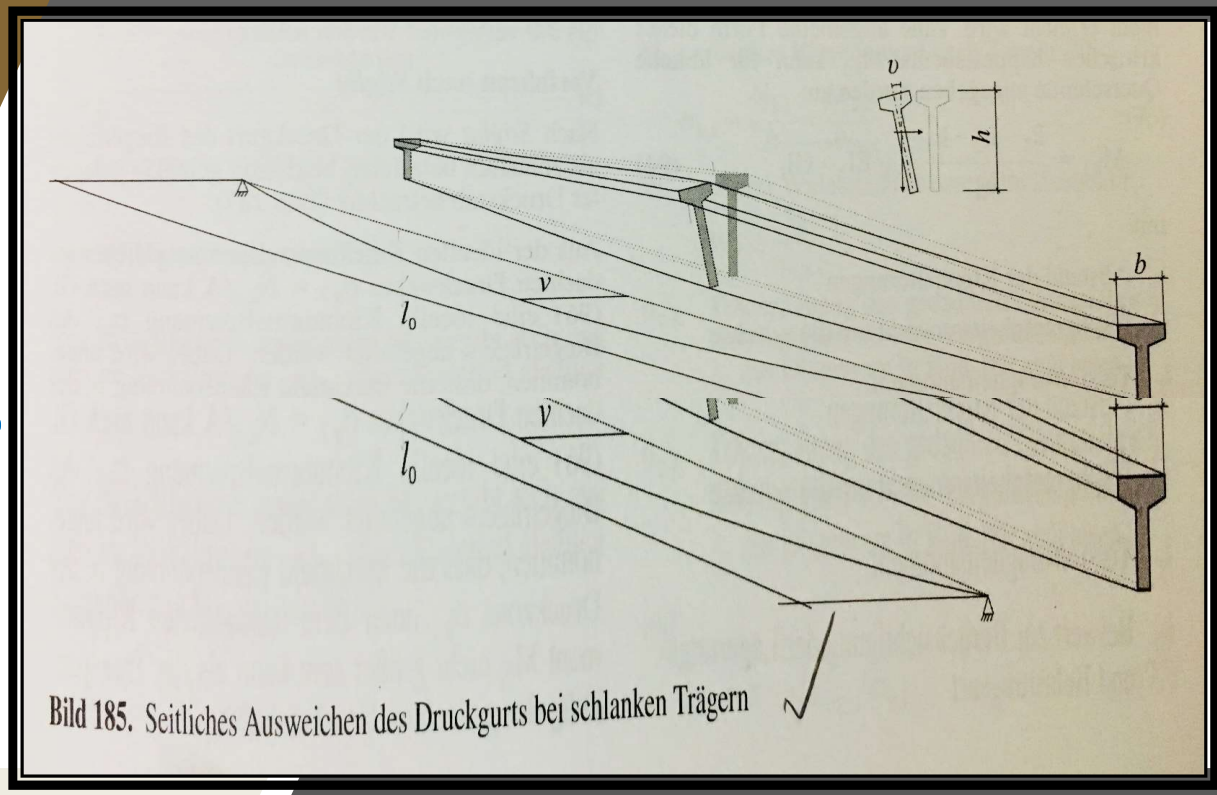


Bild 185. Seitliches Ausweichen des Druckgurts bei schlanken Trägern

9. SAFETY AGAINST TILTING (Contd;)

- LONG SLENDER BEAMS REQUIRE TO BE SAFEGUARDED AGAINST TILTING ON DESHUTTERING, SHIFTING, TRANSPORT, ERECTION & IN THE FINAL POSITION.
- TO ENSURE THE ABOVE, THE FLANGE WIDTH OF THE BEAM SHALL BE A MINIMUM AS PER THE FOLLOWING.

ERECTION: (DIN EN 1992-1-1,59)

$$b_{min} = \sqrt[4]{\left(\frac{L_0}{70}\right)^3 h}\,; \quad \frac{h}{b} \leq 5.0$$

9. SAFETY AGAINST TILTING (Contd;)

- FOR $\frac{h}{b} = 5.0$; $b_{min} = \frac{L_0}{40}$

- FOR STRUCTURAL STEEL TRUSSES, THE WIDTH OF THE COMPRESSION CHORD $b_{min} = \frac{L_0}{12}$, ERECTION (REFER STEEL STRUCTURES BY T.Y.LIN)

10. QUALITY ASSURANCE

- PRECAST SUPPLIER IS FULLY RESPONSIBLE FOR THE MATERIALS, METHODS, CONCRETE MAKING, FORMING THE PRODUCTS AND ALL RELATED OPERATIONS BY CHECKING ALL ON A CONTINUOUS BASIS AND DOCUMENT THE SAME.
- THIRD PARTY CERTIFICATION AT ALL STAGES BY REGULAR INSPECTION, EVALUATION OF TEST RESULTS AND CONTROL FACILITIES.
- ALL OBSERVATIONS SHALL BE RECORDED WITH COMMENTS FOR ACCEPTANCE, MODIFICATION OR REJECTION.

Please Mail to **kmkompella1@gmail.com**

(or)

Call me **+91 9866121998**

Thank You