



Structural Connections & Jointing Systems for Precast Concrete Structures

By: Saurabh Purandare

Purpose of Connection

The Design & Construction of Joints & Connections is the most important consideration in Precast Concrete Structures.

The purpose of Connection is,

1. To transmit forces between structural elements and/or
2. To provide Overall Stability
3. To provide Robustness (structural integrity)

Design Criterion for Joints

In addition to designing the joints for serviceability & ultimate loads (which are easy to predict & calculate), the joint shall also be designed to resist unpredictable loads due to,

1. Fire
2. Impact
3. Explosions etc.

The failure of one joint should not under any circumstances lead to structural instability (alternate load path shall be available).

Methods of Connecting

The Connections between precast elements can be achieved thro',

- Bolting

- Welding

- Grouting (wet connections)

The Method of Connection largely depends upon type of structure, seismic zone, availability of materials & hardware and skill set of site operatives.

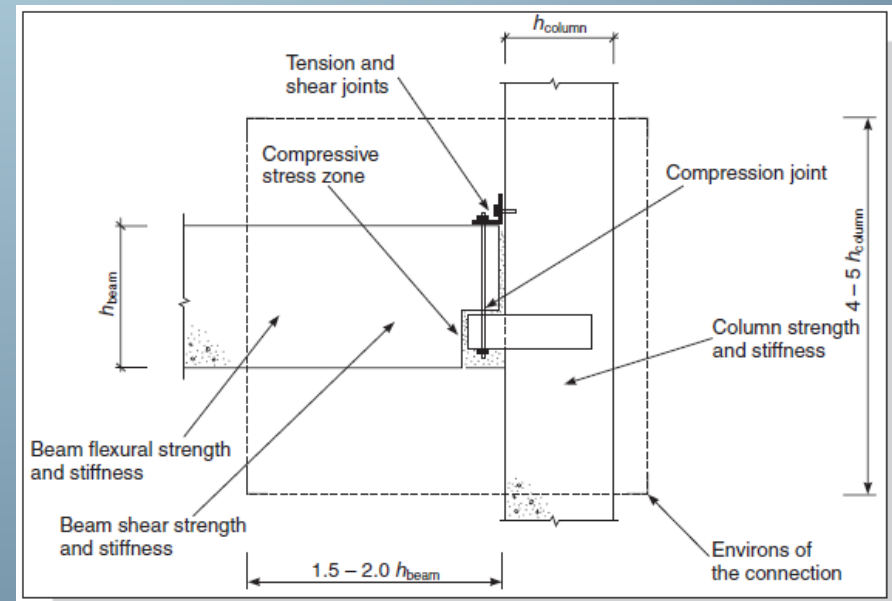
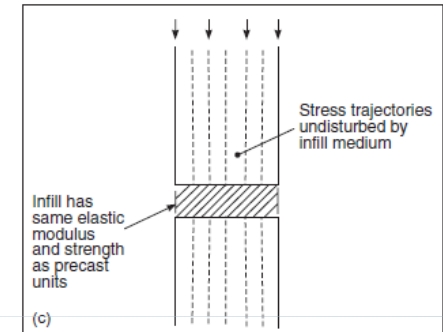
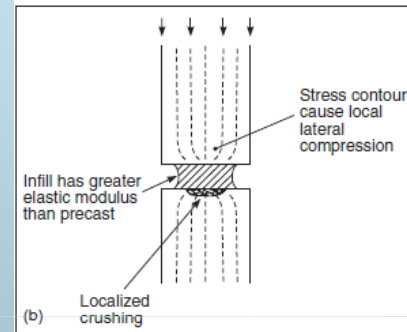
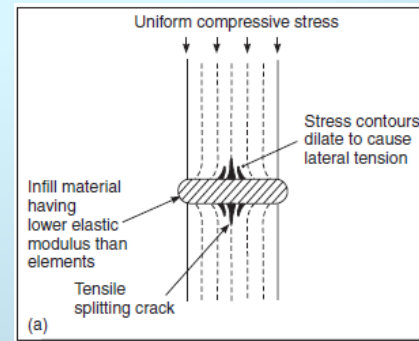
Whichever method used, the Connection should be Simple & must convey unambiguous message to site operatives.

Definition of Joint & Connection

Within a “connection”, there may be several load transferring “joints”.

A “joint” is action of forces (Compression, Tension, Shear) between two or more structural elements thro’ an intermediate medium (rubber, steel, grout etc.) The behavior of joint will depend on how much this intermediate medium differs from parent concrete.

Whereas a “connection” is the action of forces (Compression, Tension, Shear) and/or Moments (Bending, torsion) thro’ an assembly comprising of one or more interface/s (joints). The design of connection therefore is function of both the structural elements & joints between them.

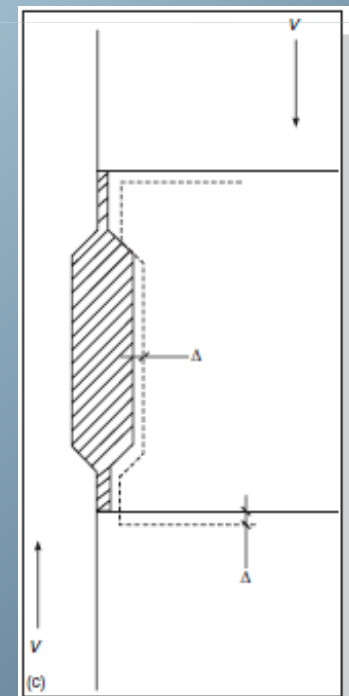
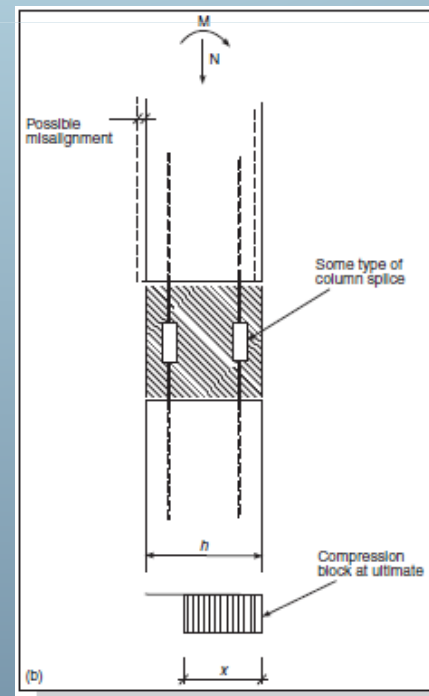
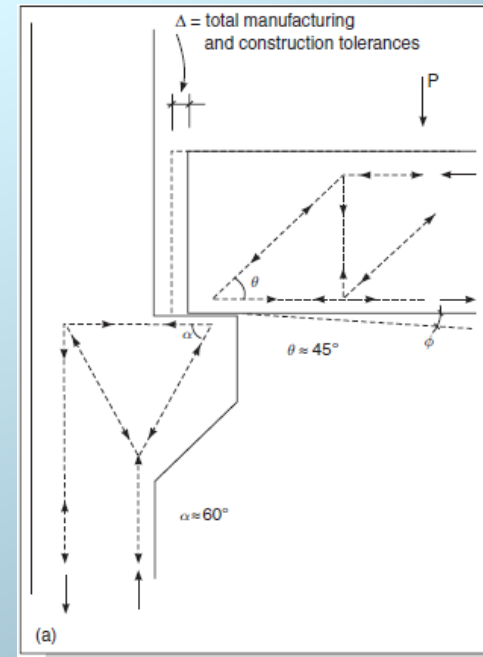


Basic Mechanisms of load transfer in a Connection

Strut & Tie for transfer of Bearing forces

Coupled joints for transfer of bearing forces and/or Moments & Torsion

Shear Friction for transfer of shear with or without compression



Compression Joints

The compression (bearing) joints can be formed by,

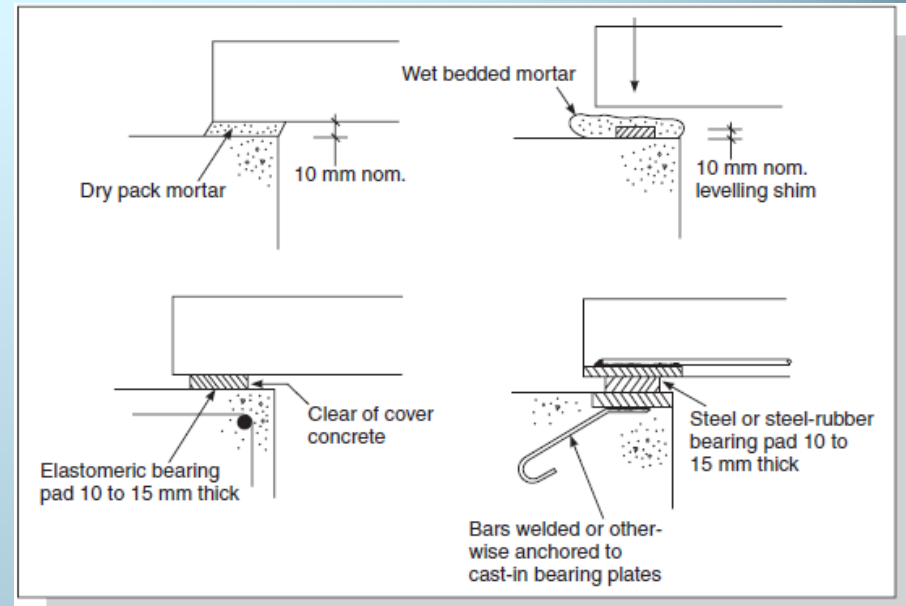
Dry Pack Mortar

Bedded Bearing (semi wet mortar)

Soft Bearing

Steel Bearing

Extended bearings thro' wet joints (where temporary bearings are small)



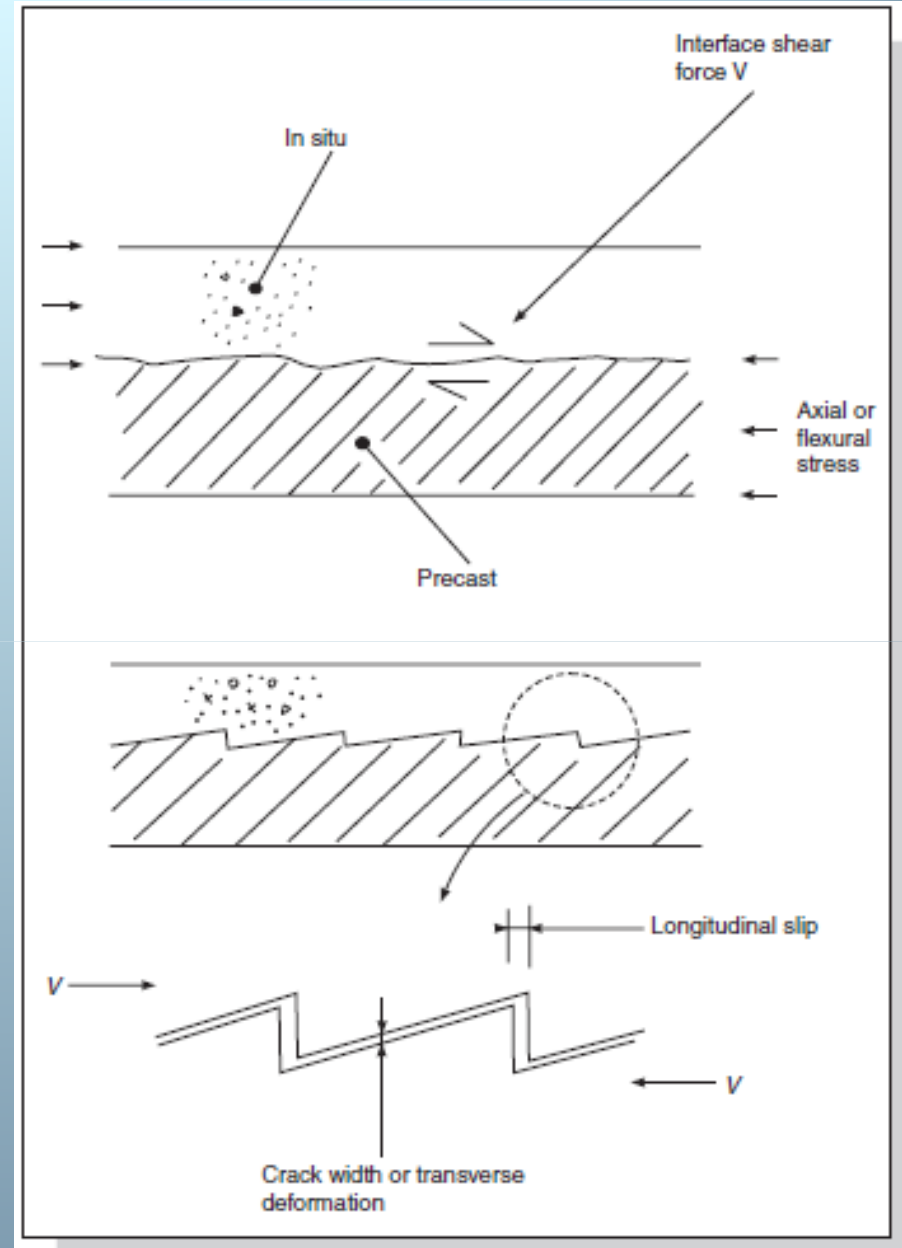
Shear Joints

The shear forces can be transferred between two Precast Elements by one or more of following Methods,

1. Adhesion & Bonding (Generally avoided)
2. Shear Friction
3. Shear Keys
4. Dowel Action
5. Mechanical Connection

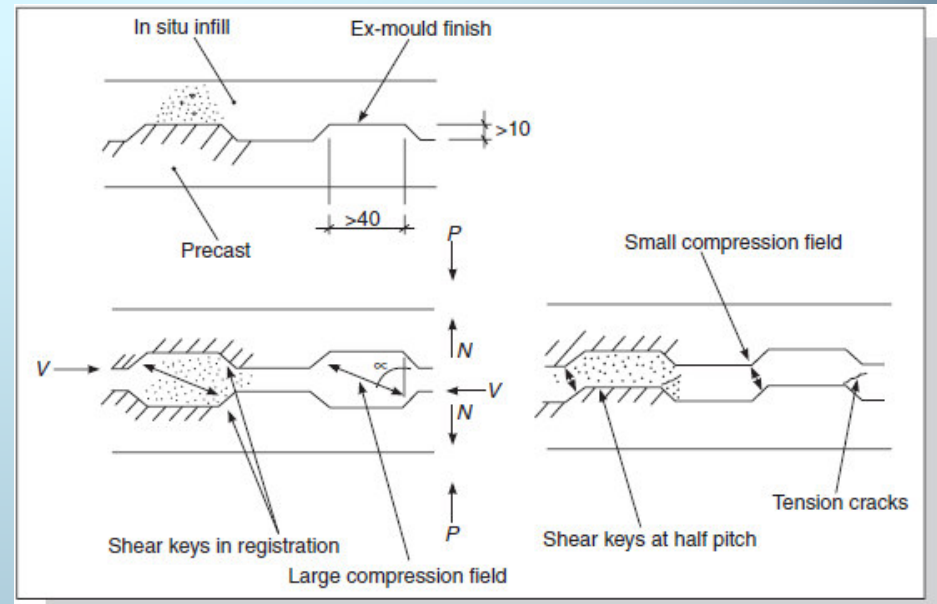
Shear Joints- Shear Friction

The Shear Friction relies on nature of interface between contact surfaces. When a surface has certain roughness, the shear will be transferred by Friction even if the surface is cracked.



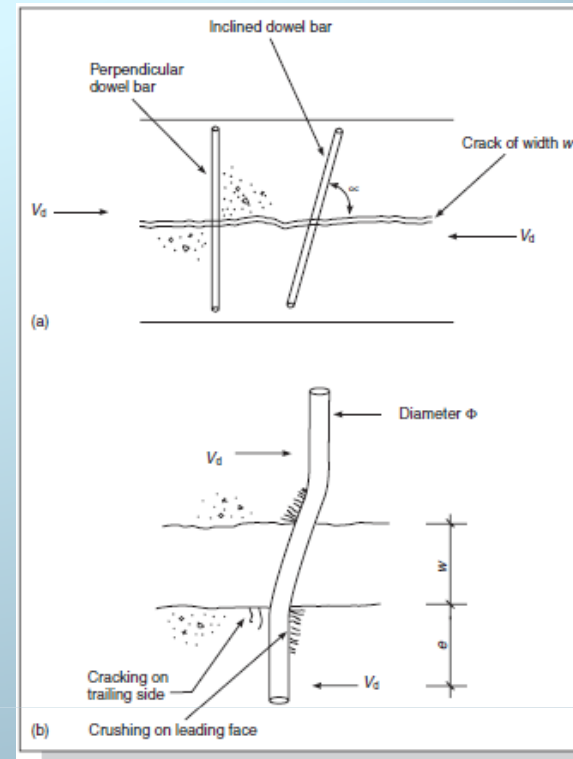
Shear Joints – Shear Keys

Shear Keys rely on mechanical interlock and the development of a confined diagonal compressive strut across the shear plane.



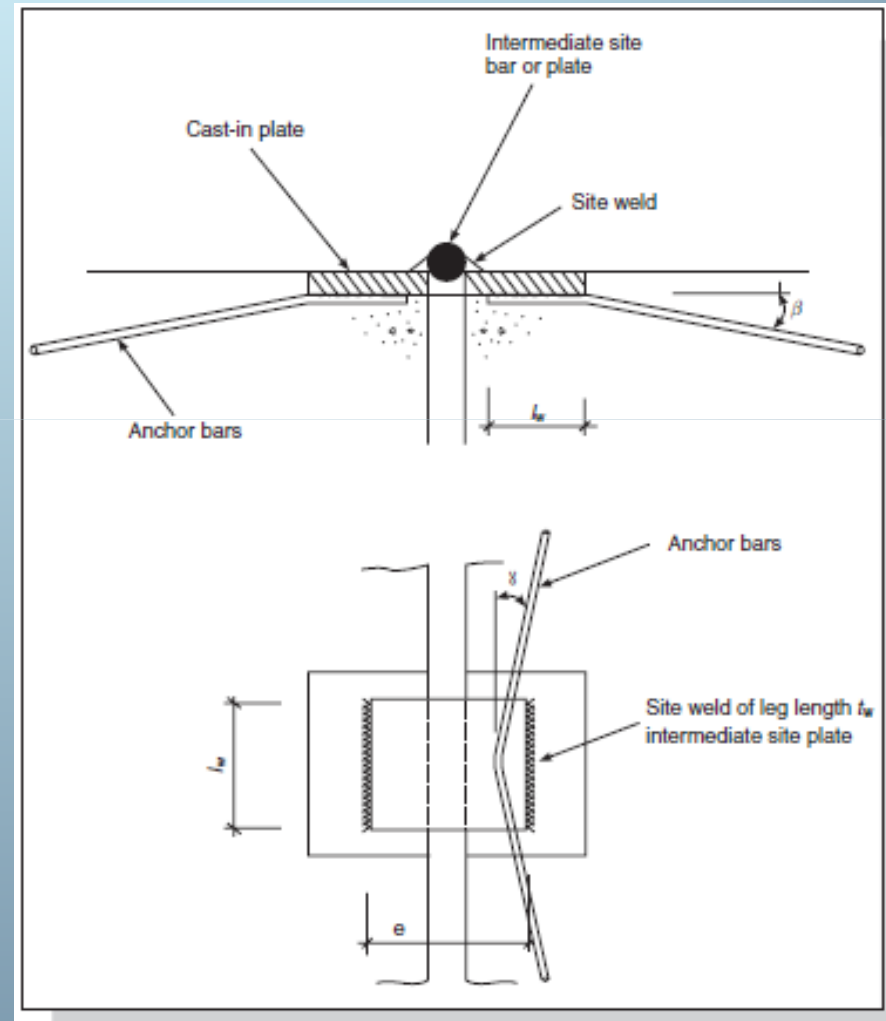
Shear Joints – Dowel Action

Where reinforcing bars are placed across the joints, the shear force is transferred thro' "dowel Action". Where dowel bars are used, the capacity of dowel action alone is assumed to act ignoring shear friction/shear keys



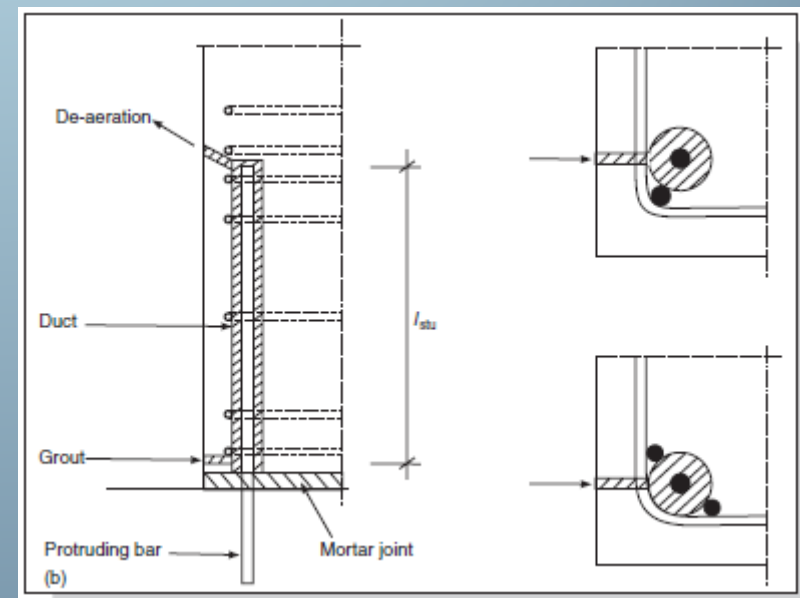
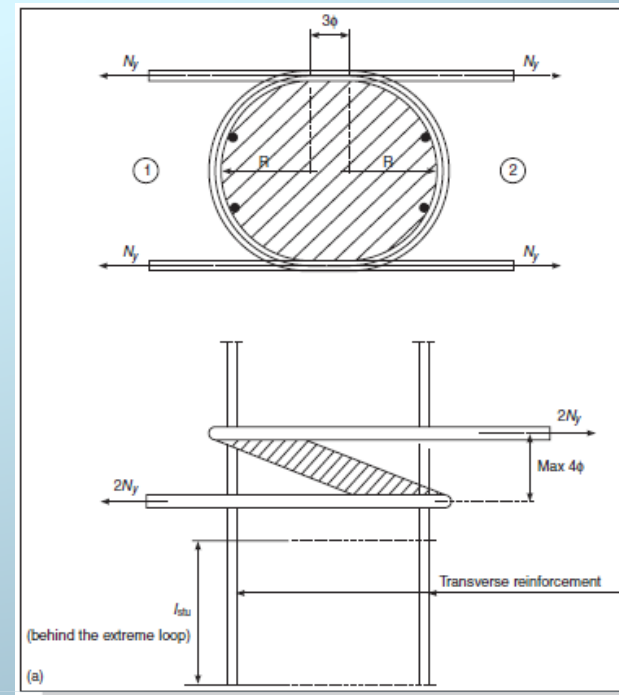
Shear Joints – Mechanical Device

Shear transfer may be achieved locally using mechanical connection. The Design of such connection shall be considered carefully as a very high stiffness of the joint is made locally due to site welding/high friction grip bolts leading to less flexibility of joint.



Tension Joints

Lapping of rebars or loops is often used to transfer tension between precast elements. The precast elements are cast with projecting bars/loops which are embedded in wet concrete / grout.



Sealants in Joints

- Connections Precast Concrete Construction involves interface between old concrete (precast) & new concrete (grout) and hence are vulnerable to cracking due to temperature changes & movement.
- By care full designing of such joints, the crack widths in the joints can be limited to an extent but can not be avoided altogether.
- To achieve water tightness, sealants in external joints as a must.

Choice of Sealants

- The variety of sealants are available in market e.g. Poly Urethane based , Poly Sulfide based or Silicon based.
- The choice of sealant for a particular project will depend upon the type of structure, strain levels in joints, ambient temperature, seasonal changes, life of sealant and it's elongation properties.

Conclusion

- The connection generally comprises of one or more joints (compression/shear/tension joints)
- There are well established methods to design the joints for the subjected forces.
- The choice of joints depend upon the stress levels at serviceability/ultimate stage in addition to fire, impact, accidental loads etc.
- The alternate load path shall be available in case of failure of one joint.

Thank You



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info@innovela.in