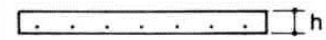
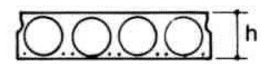
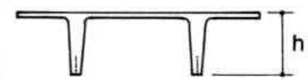
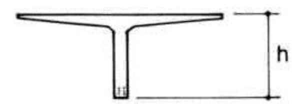
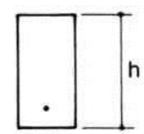
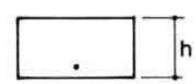
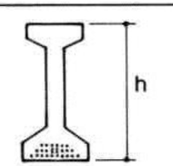
Table 9.3.1.1—Minimum depth of nonprestressed beams

Support condition	Minimum h[1]
Simply supported	$\ell/16$
One end continuous	$\ell/18.5$
Both ends continuous	$\ell/21$
Cantilever	$\ell/8$

[1]Expressions applicable for normalweight concrete and Grade 420 reinforcement. For other cases, minimum h shall be modified in accordance with 9.3.1.1.1 through 9.3.1.1.3, as appropriate.

Type of element	Live load psf (kN/m²)	Span/depth, ℓ/h ratio
	<dead load	40
	50 (2.4) 100 (4.8)	40-50 32-42
	50 (2.4) 100 (4.8)	20-30 18-28
	50 (2.4) 100 (4.8)	23-32 19-24
	<dead load	20
	<dead load	30
	highway loading	18

Typical span-to-depth ratio for simply supported prestressed concrete member

Strength of Concrete

The minimum grades of concrete for prestressed applications are as follows:

1) 30 MPa for post-tensioned members.

2) 40 MPa for pre-tensioned members.

Table 24.5.2.1—Classification of prestressed flexural members based on f_t

Assumed behavior	Class	Limits of f_t
Uncracked	U[1]	$f_t \le 0.62\sqrt{f'_c}$
Transition between uncracked and cracked	T	$0.62\sqrt{f'_c} < f_t \le 1.0\sqrt{f'_c}$
Cracked	C	$f_t > 1.0\sqrt{f'_c}$

[1]Prestressed two-way slabs shall be designed as Class U with $f_t \le 0.50\sqrt{f'_c}$.

Stages of loading

Unlike RC which has the ultimate loading stage, Prestressed concrete involves multiple stages of loading. The stresses in the concrete section must remain below the maximum limit at all times.

Typical stages of loading are:

1- Initial Stage (Immediately after Transfer of Prestress):

- Full prestress force
- M_{LL} =0 (M_g only).

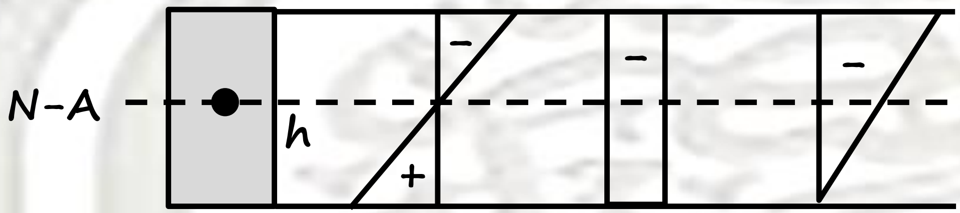
2- Service Stage:

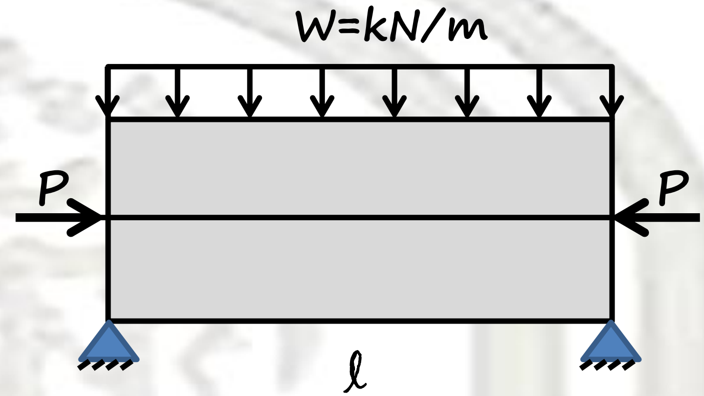
- Prestress loss has occurred
- M_{LL} + M_{DL} (LL is live load DL is dead load)

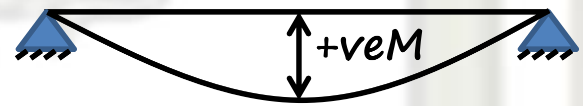
Position of Prestressing Steel:

(−) Comp. and (+) Tens.

Case (1):







Due to load

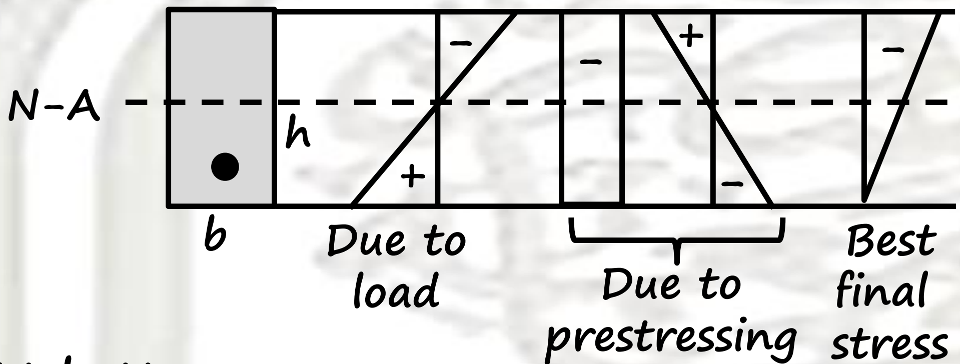
At bottom:

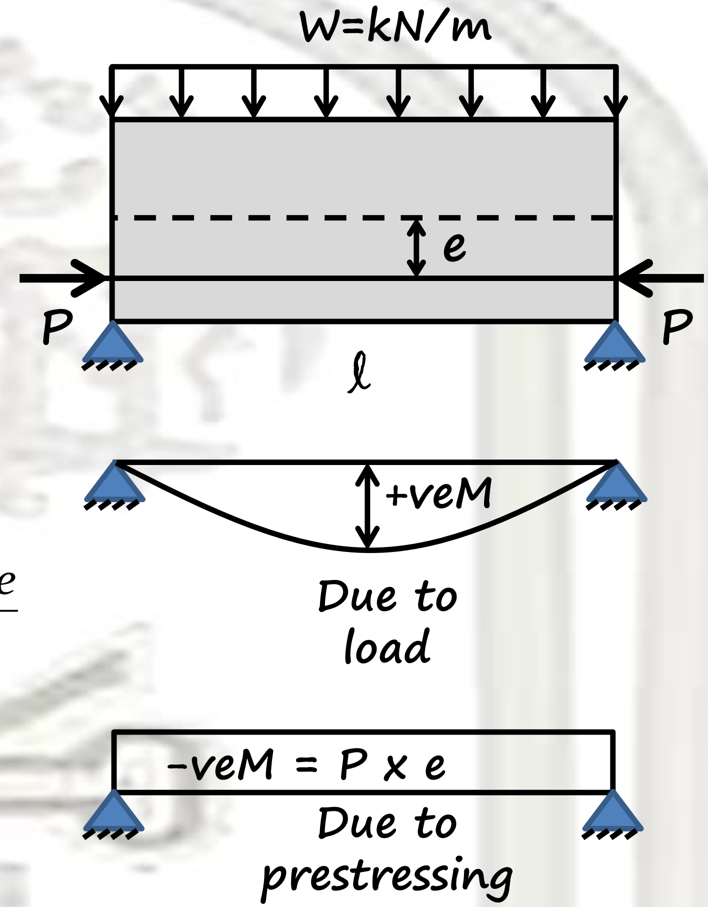
$$f_{ten.} = \frac{MC}{I} = \frac{6M}{bh^2} \quad , \quad f_{comp.} = \frac{P}{A} = \frac{P}{bh}$$

To get zero tension stress:

$$f_{ten.} = f_{comp.} \rightarrow \frac{6M}{bh^2} = \frac{P}{bh} \rightarrow P = \frac{6M}{h}$$

Case (2): (-) Comp. and (+) Tens.





At bottom:

$$f_{ten.} = \frac{MC}{I} = \frac{6M}{bh^2} \quad , \quad f_{comp.} = \frac{P}{A} + \frac{MC}{I} = \frac{P}{bh} + \frac{6P \times e}{bh^2}$$

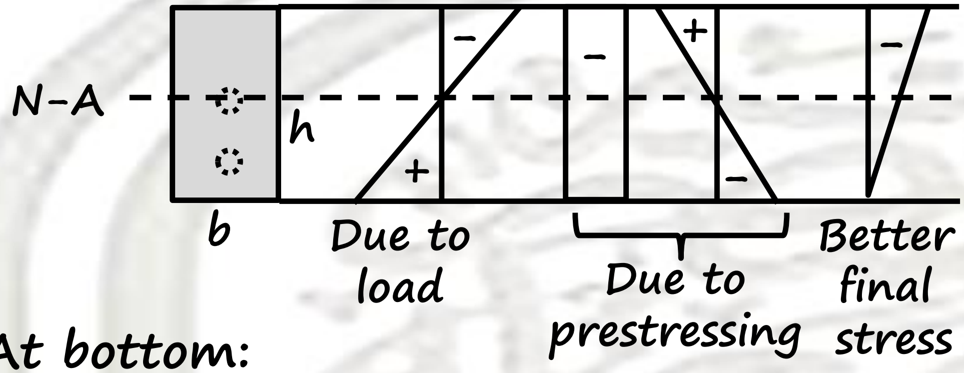
To get zero tension stress:

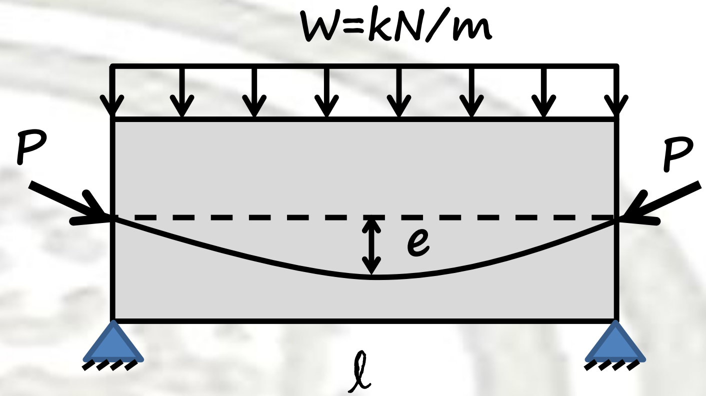
$$f_{ten.} = f_{comp.} \rightarrow \frac{6M}{bh^2} = \frac{P}{bh} + \frac{6P \times e}{bh^2} \rightarrow P = \frac{6M}{h + 6e}$$

For rectangular section, Max. e= h/6

$$P = \frac{6M}{2h} = \frac{3M}{h} \quad < \text{Case (1)}$$

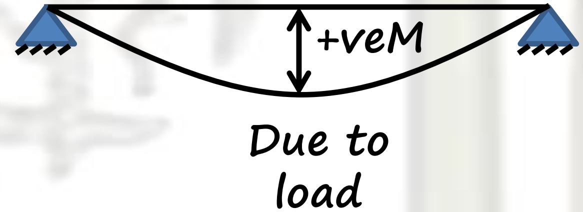
Case (3): (-) Comp. and (+) Tens.





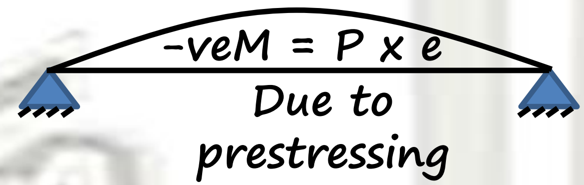
At bottom:

$$f_{ten.} = \frac{MC}{I} = \frac{6M}{bh^2} \quad , \quad f_{comp.} = \frac{P}{A} + \frac{MC}{I} = \frac{P}{bh} + \frac{6P \times e}{bh^2}$$



To get zero tension stress:

$$f_{ten.} = f_{comp.} \rightarrow \frac{6M}{bh^2} = \frac{P}{bh} + \frac{6P \times e}{bh^2} \rightarrow P = \frac{6M}{h + 6e}$$



For e= 0.5h-0.05h=0.45h

$$P = \frac{6M}{3.7h} = \frac{1.62M}{h}$$ < Case (1 and 2)

Conclusion:

1- the better path of (P) force looks like the shape of B.M diagram.
2- At the ends, B.M=0 because of e=0, therefor no tension stresses due to prestressing.