... CONTINUATION OF 'SHEAR-WALL PROBLEM' 5/5/26

- BOOKS: P. POZZATI "TEORIA E TECNICA DELLE STRUTTURE" VOL 2-2

IN ENGLISH: CHECK BOOKS SPECIALIZED TO STRUCT. MECHANICS OF HIGH-RISE BUILDINGS

- AFTER HAVING OBTAINED M_{EJ}, M_{GA} AND T_{EJ}, T_{GA}, WE SHOULD CHECK THAT:

$$M_{EJ}(z) + M_{GA}(z) = \underbrace{-w\frac{(H-z)^2}{2}}_{\text{"PARABOLA"}} \quad ; \quad T_{EJ}(z) + T_{GA}(z) = \underbrace{w(H-z)}_{\text{LINEAR TOT. SHEAR}}$$

- SOME CLOSED-FORM EXPRESSIONS:

$$M_{EJ}(z) = -w\left[\frac{H}{\alpha}\left(\tanh(\alpha H)\cosh(\alpha z) - \sinh(\alpha z)\right) + \frac{1}{\alpha^2}\left(\frac{\cosh(\alpha z)}{\cosh(\alpha H)} - 1\right)\right]$$

$$T_{EJ}(z) = w\left[H\left(\cosh(\alpha z) - \tanh(\alpha H)\sinh(\alpha z)\right) - \frac{1}{\alpha}\left(\frac{\sinh(\alpha z)}{\cosh(\alpha H)}\right)\right]$$

$$y(z) = \frac{wH^4}{EJ}\left[\frac{1}{(\alpha H)^4}\left[\frac{\alpha H\sinh(\alpha H)+1}{\cosh(\alpha H)}\left(\cosh(\alpha z)-1\right) - \alpha H\sinh(\alpha z) + (\alpha H)^2\left[\frac{z}{H} - \frac{1}{2}\left(\frac{z}{H}\right)^2\right]\right]\right]$$

IF YOU CHOOSE THE ASSIGNMENT RELATED TO THIS PROBLEM, CALCULATE FROM SCRATCH ALL FUNCTIONS BY IMPOSING B.C.'S !!

(PRESENTATION OF THE TEXT OF THE ASSIGNMENT)

TO CONCLUDE, WE HAVE PRESENTED A SIMPLIFIED, BUT EFFECTIVE, MODEL OF INTERACTION BETWEEN A FLEXURAL CANTILEVER AND A FRAME IN HIGH-RISE BUILDINGS. MAIN LIMITATIONS OF THE MODEL ARE:

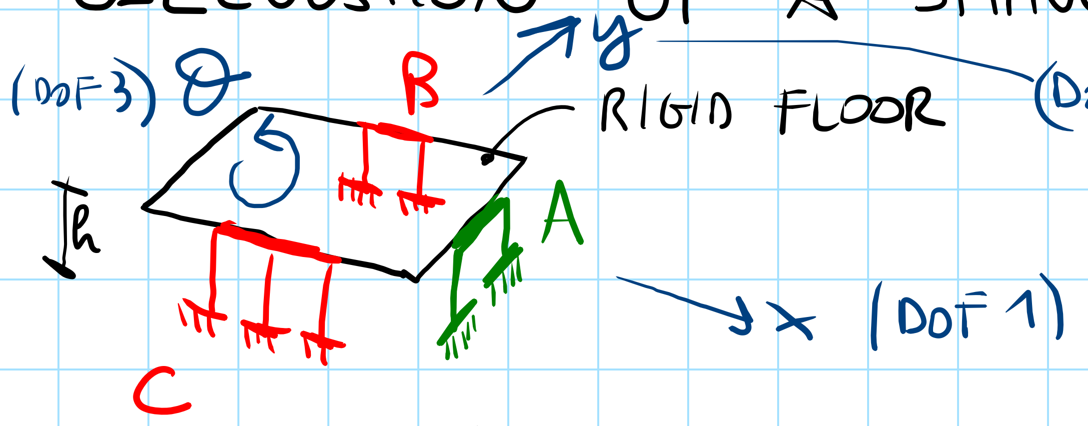
- FRAME GIRDERS (MAIN BEAMS OF THE FRAME) ARE CONSIDERED INFINITELY STIFF (SPECIALLY, W.R.T. THE ELASTICITY OF THE PILLARS)

- PILLARS HAVE THE SAME CROSS SECTION AT EVERY HEIGHT. THIS IS NOT TRULY REALISTIC; IF WE RELAX THE HYPOTHESIS $\longrightarrow$ $GA_{eq} = f(x)$
  NOT CONSTANT.

- THE FOUNDATIONS ARE CONSIDERED "AS PERFECT": NO COMPLIANCE IS ASSUMED. HOWEVER, WE CAN IMAGINE THAT INTERACTION OF CANTILEVER/FRAME WITH STRUCTURES OF FOUNDATIONS BE MORE COMPLEX (I.E.: LOCALIZED ELASTIC STIFFNESSES PRESENT)

CALCULATION OF A STIFNESS MATRIX OF A 3-DOF SYSTEM IN SPACE

(x, y, θ)



$$\underset{\sim}{K} = \begin{bmatrix} K_{11} & \cdots & K_{13} \\ \vdots & & \vdots \\ K_{31} & \cdots & K_{33} \end{bmatrix}$$

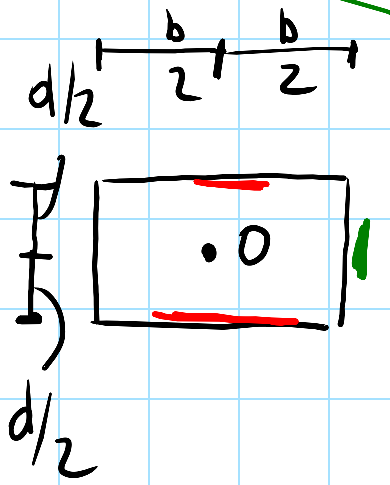
BY DEFINITION:

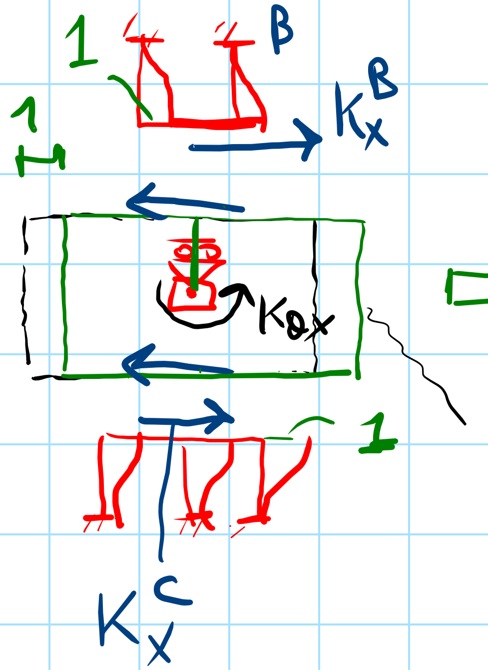
K_{ij}: FORCE RELATED TO i-DOF WHEN j-DOF $=1$, THE OTHERS ARE NULL.

$$\boxed{\underset{\sim}{K}\,\underline{u} = \underline{F}}$$

$\boxed{x=1,\ y=\theta=0} \Rightarrow K_{11}, K_{21}, K_{31}$ REACTIONS ARISING IN AUXILIARY CONSTRAINTS

$K_{xx}\quad K_{yx}\quad K_{\theta x}$





$K_x^A = 0$

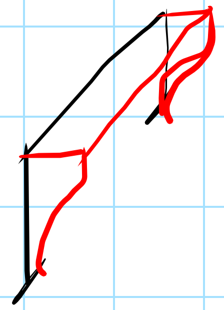
EQUILIBRIUM OF THE FLOOR:

$\xrightarrow{+}$: $K_{xx} - K_x^C - K_x^B = 0$

$+\uparrow$: $K_{yx} = 0$

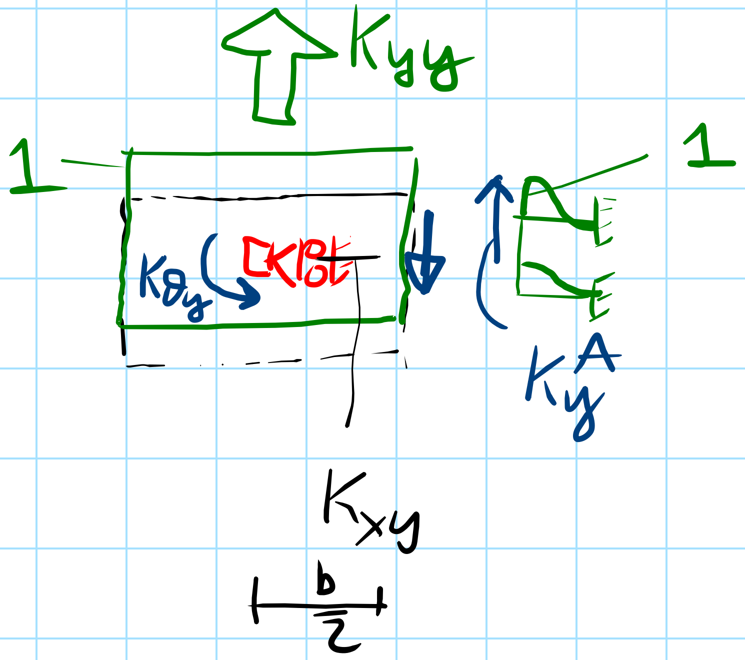
$\overset{+}{\circlearrowleft}$: $K_{\theta x} + K_x^B \frac{d}{2} - K_x^C \frac{d}{2} = 0$

$$\boxed{K_{xx} = K_x^B + K_x^C\ ;\quad K_{yx} = 0\ ;\quad K_{\theta x} = \left(K_x^C - K_x^B\right)\frac{d}{2}}$$



WE NEGLECT FRAME RESISTANCE OUT-OF-PLANE

$$\boxed{x=\theta=0,\ y=1}$$



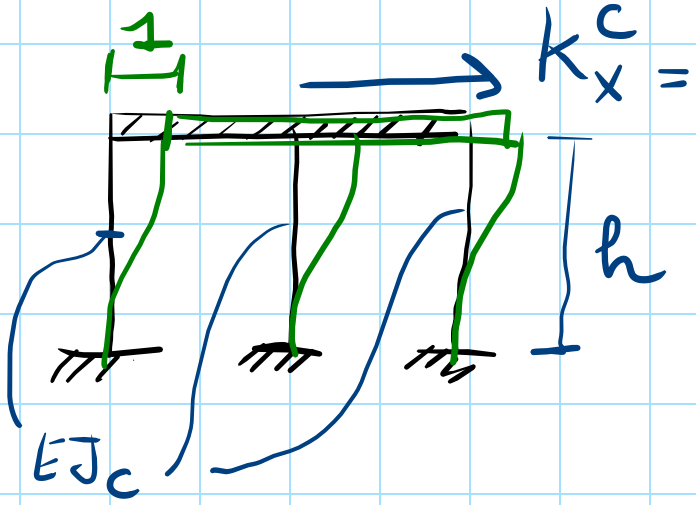
EQUIL:

$$\left.\begin{aligned} \xrightarrow{+}:&\ K_{xy}=0 \\ +\uparrow:&\ K_{yy}-K_y^A=0 \\ +\circlearrowleft:&\ K_{\theta y}-K_y^A\frac{b}{2}=0 \end{aligned}\right\} \quad \begin{aligned} K_{xy}&=0 \\ K_{yy}&=K_y^A \\ K_{\theta y}&=K_y^A\frac{b}{2} \end{aligned}$$

$$\begin{bmatrix} K_x^B+K_x^C & 0 & \\ 0 & K_y^A & \\ (K_x^C-K_x^B)\frac{a}{2} & K_y^A\frac{b}{2} & \end{bmatrix}$$

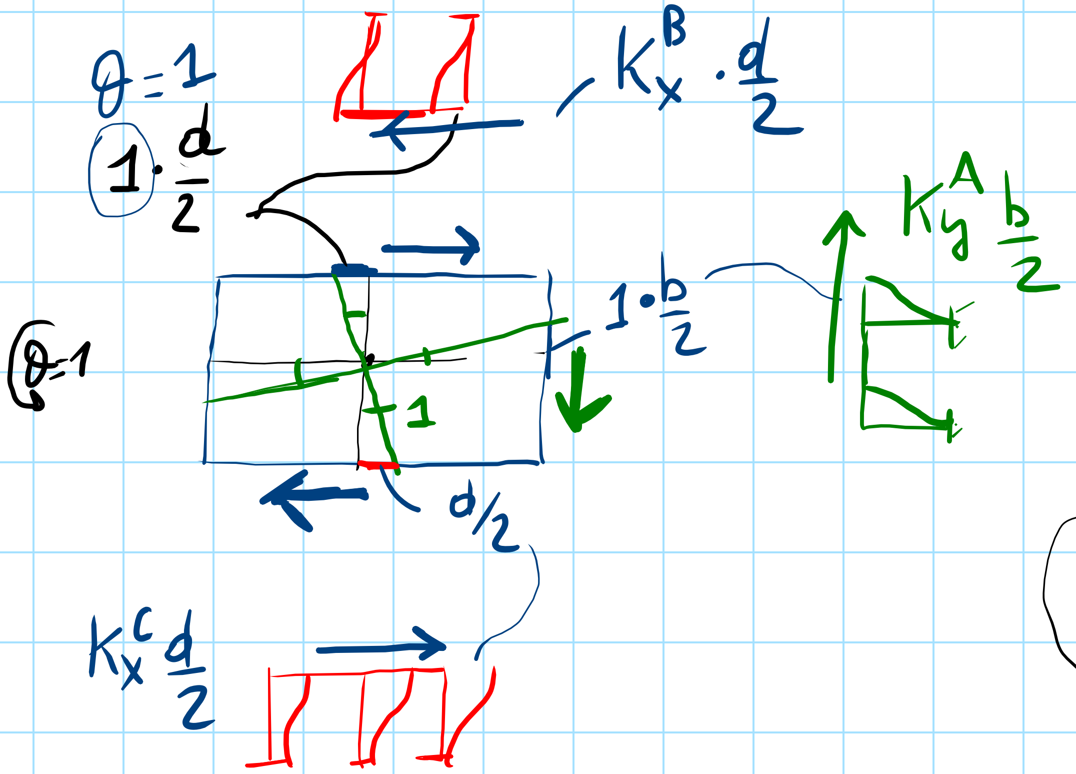
NOTE:

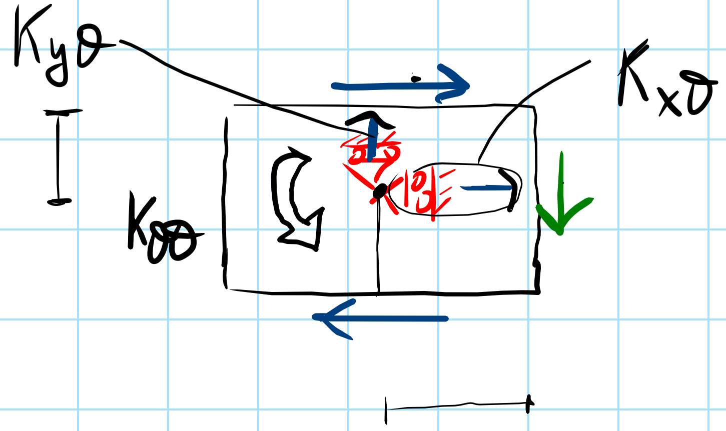
$K_x^B,\ K_x^C,\ K_y^A$?



$$K_x^C = 3\cdot 12\,\frac{EJ_c}{h^3}$$

$\boxed{\theta = 1,\ x = y = 0}$





$$+\circlearrowleft\theta:\quad K_{\theta\theta} - \underbrace{K_x^C \frac{d}{2}}\cdot\frac{d}{2} - K_y^A \cdot\frac{b}{2}\cdot\frac{b}{2} - K_x^B \frac{d}{2}\frac{d}{2} = 0$$

$$\xrightarrow{+}:\quad K_{x\theta} - K_x^C \frac{d}{2} + K_x^B \frac{d}{2} = 0$$

$$+\uparrow:\quad K_{y\theta} - K_y^A \frac{b}{2} = 0$$

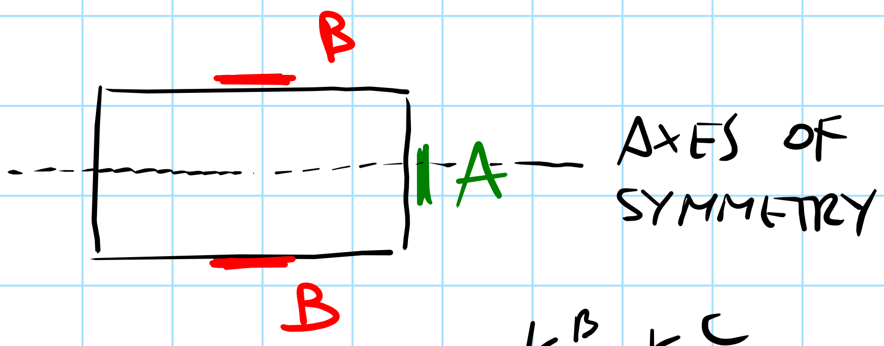
$$K_{\theta\theta} = K_x^C \frac{d^2}{4} + K_y^A \frac{b^2}{4} + K_x^B \frac{d^2}{4} \quad ; \quad K_{x\theta} = \left(K_x^C - K_x^B\right)\frac{d}{2}$$

$$K_{y\theta} = K_y^A \frac{b}{2}$$

$$\begin{bmatrix} K_x^C + K_x^B & 0 & \boxed{\left(K_x^C - K_x^B\right)\frac{d}{2}} \\ 0 & K_y^A & K_y^A \frac{b}{2} \\ \boxed{\left(K_x^C - K_x^B\right)\frac{d}{2}} & K_y^A \frac{b}{2} & K_{\theta\theta} \end{bmatrix} = [\underset{\sim}{K}]$$

SYMMETRY IS CHECKED. RECALL THAT SYMM. OF $[\underset{\sim}{K}]$ DEPENDS ON BETTI'S THEOREM.

• SOME PARTICULAR CASES

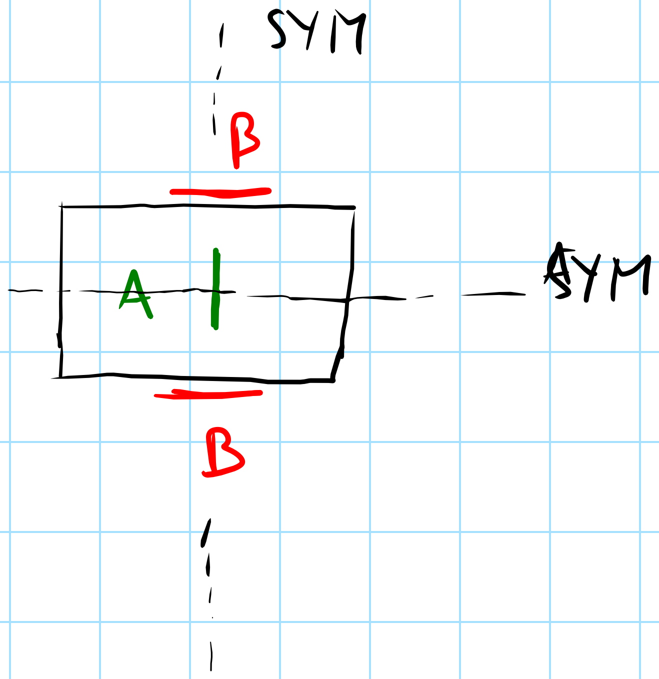


$$[\underset{\sim}{K}] = \begin{bmatrix} X & 0 & 0 \\ 0 & X & X \\ 0 & X & X \end{bmatrix}$$

TRANSLATION ALONG X DOES NOT INVOLVE ANY "TORSIONAL" EFFECT

$K_x^B = K_x^C$

(X: NON NULL VALUE)



$$[\underset{\sim}{K}] = \begin{bmatrix} X & 0 & 0 \\ 0 & X & 0 \\ 0 & 0 & X \end{bmatrix}$$

DIAGONAL:

TRANSLATIONS ARE DECOUPLED BETWEEN THEM AND DECOUPLED FROM ROTATION

MECHANICS OF MASONRY STRUCTURES ("BASED ON "NO-TENSION" MATERIAL)

GOOD FOR: PILLARS, ARCHES, WALLS

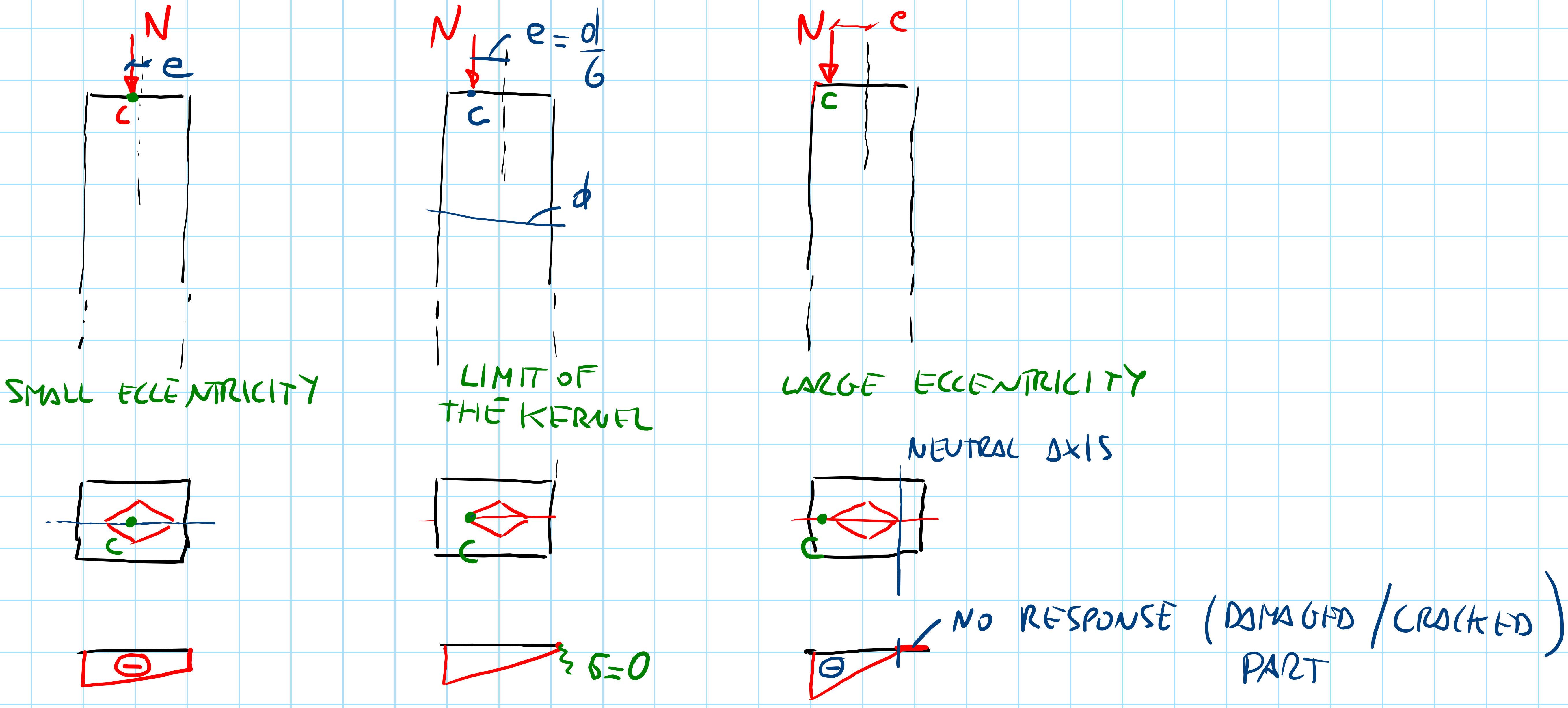
HEYMAN'S HYPOTHESES FOR MODELLING MASONRY STRUCTURES

1) MASONRY HAS NO TENSILE STRENGTH

2) " " INFINITE COMPRESSION RESISTANCE

3) FAILURE OF A MASONRY STRUCT. DUE TO SLIDING OF BLOCKS IS RULED OUT (FRICTION BETWEEN BLOCKS IS ALWAYS SUFFICIENT TO AVOID SLIDING)

COMPRESSED PILLAR WITH AN ECCENTRIC LOAD



ALL SECTION IS COMPRESSED

ALL SECTION IS COMPRESSED

ONLY A REDUCED PART OF THE SECTION IS COMPRESSED. THE OTHER PART IS DAMAGED / CRACKED.