Progetto DPC-ReLUIS 2022-2024 WP12

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

TASK 12.1 CONTRIBUTI NORMATIVI RELATIVI A COSTRUZIONI CIVILI E INDUSTRIALI DI ACCIAIO E COMPOSTE ACCIAIO-CALCESTRUZZO

Resistenza a collasso progressivo delle strutture intelaiate in acciaio

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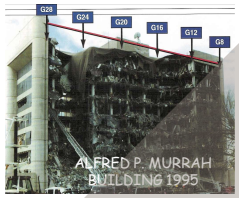
PROGRESSIVE COLLAPSE

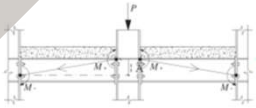


"SPREAD OF AN INITIAL LOCAL FAILURE FROM ELEMENT TO ELEMENT RESULTING, EVENTUALLY, IN THE COLLAPSE OF AN ENTIRE STRUCTURE OR A DISPROPORTIONATELY LARGE PART OF IT"

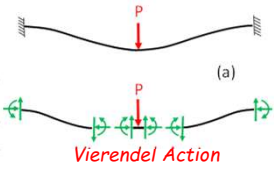
ALTERNATE PATH METHOD (APM)

The Alternate Path Approach presumes that a critical element is removed from the structure, due to an abnormal loading, and the structure is required to redistribute the gravity loads to the remaining undamaged structural elements.

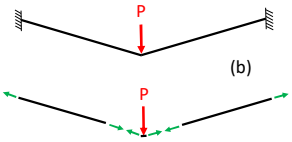
RESERVES TO FIND ALTERNATE LOAD PATHS



Compressive Arch Action

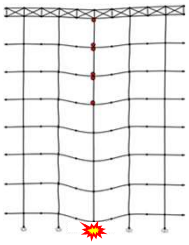


Vierendel Action



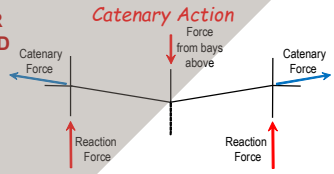
Catenary Action

After a column is destroyed by abnormal loads, the tensile axial force of the beam gradually increased, while the bending moment decreased, and the load-resistance mechanism shifts from a flexural mechanism to a catenary mechanism, with the axial force becoming the prevailing factor.

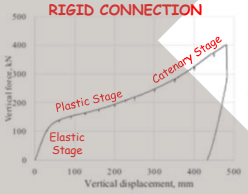


Vertical load bearing elements acting as suspension

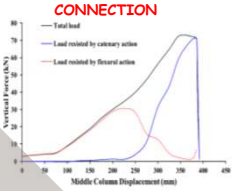
NONLINEAR MODELS AND METHODS



RIGID OR SEMI-RIGID CONNECTION

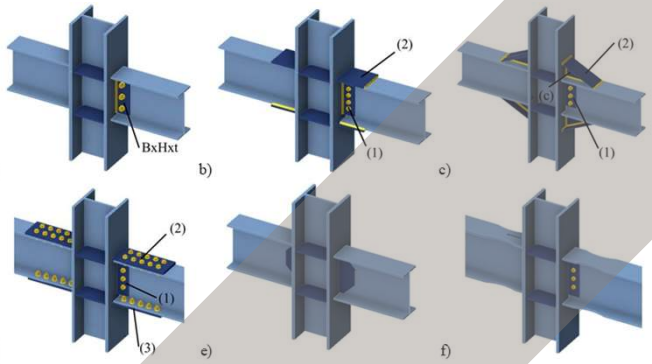


FLEXIBLE CONNECTION



In MRFs, the beam-to-column joints were assumed rigid, full-strength and stronger than the beams. Thus, the model allows plastic hinges to form in beams and columns, not in connections. While undergoing large deformation, the beam-to-column connections are subjected to moment, shear, and tension in conjunction with high ductility demand. The addition of axial loads significantly reduces the rotation capacity of the connections. Even moment frames appropriately designed for seismic loads may not resist progressive collapse.

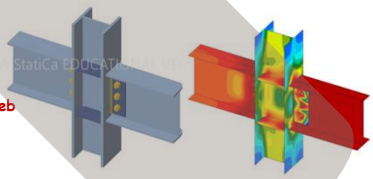
The standard seismic nonlinear modeling parameters and acceptance criteria should be upgraded to account for the effects of loading (monotonic vs. cyclic) and the ultimate state of strain (moment only vs. moment-axial tension interaction).



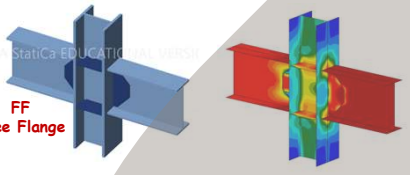
SEISMICALLY DESIGNED SPECIAL MOMENT FRAME CONNECTIONS

a) WUF-B (Welded Unreinforced flange, bolted web); b) WFP (Welded flange plate); c) TBH (Top and Bottom Haunce); d) BFP (Bolted flange plate); e) FF (Free Flange); f) RBS (Reduced beam section).

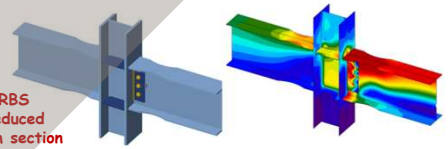
WUF-B Welded Unreinforced flange, bolted web



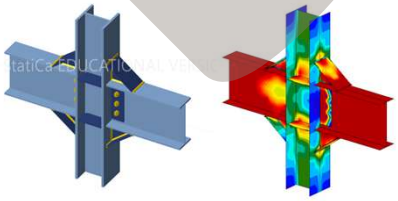
FF Free Flange



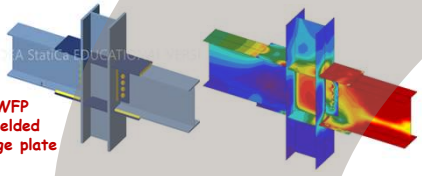
RBS Reduced beam section



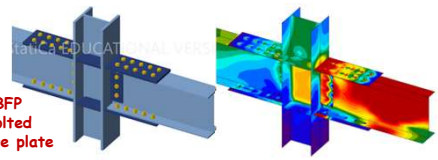
TBH Top and Bottom Haunce



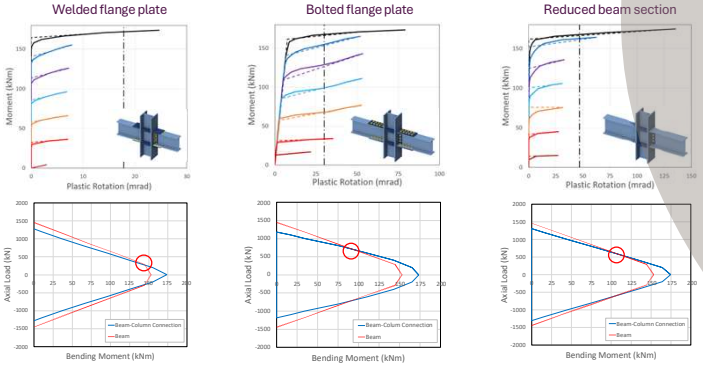
WFP Welded flange plate



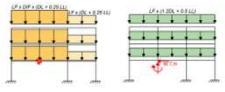
BFP Bolted flange plate



Welded flange plate | Bolted flange plate | Reduced beam section



- Model M1: P-M Plastic hinges in beams
- Model M2: P-M Plastic hinges in both beams and connections
- IDEAStatiCa – Plastic rotation capacity
- GSA – Plastic rotation capacity



Welded flange plate | Bolted flange plate | Reduced beam section