EVALUATION OF THE EFFECT OF LINK BEAMS STIFFENERS WITH DIFFERENT CROSS-SECTIONS

Samira EBRAHIMI
PhD Student in Earthquake Engineering, Tehran University, Tehran, Iran
samira.ebrahimi@ut.ac.ir

Hamzeh SHAKIB
Professor, Tarbiat Modares University, Tehran, Iran
shakib@modares.ac.ir

Masoud SOLTANI MOHAMMADI
Associate professor, Tarbiat Modares University, Tehran, Iran
msoltani@modares.ac.ir

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Link beams of eccentrically braced frames similar to ductile fuses, in addition to avoiding bracing buckling, attract earthquake energies. Link beams, stiffeners have significant effect in earthquake energy dissipation and their suitable arrangement, causes increasing the rotation capacity of link beams. I-shaped and tubular cross-sections are used in link beams. Berman and Burunue presented a model for tubular link beams in 2007. In their model, tubular link beams, stiffeners are connected to the flange and the web from the outside around (Berman and Burunue, 2007). I-shaped link beams, stiffeners are connected to the web from two sides.

In this investigation, link beams with tubular and I-shaped cross-sections that are similar in area, moment of inertia, length and stiffener spacing, were compared together and effect of their stiffeners in earthquake energy dissipation was studied. Also in this study, tubular link beams for different values of flange compactness ratio and web compactness ratio were compared together and this question has been answered that the flange compactness ratio has more impact on the rotation capacity of tubular link beams or web compactness ratio?

In this investigation, the link beams were modelled in ABAQUS and in order to loading, AISC-2005 loading protocol was used. In this modelling, shell elements for flanges, webs and stiffeners have been utilized. And also the nonlinear kinematic hardening plasticity material model has been used. For validating the numerical studies, the experimental results of Berman and Bruneau have been utilized (Figure 1) (Berman and Burunue, 2007).

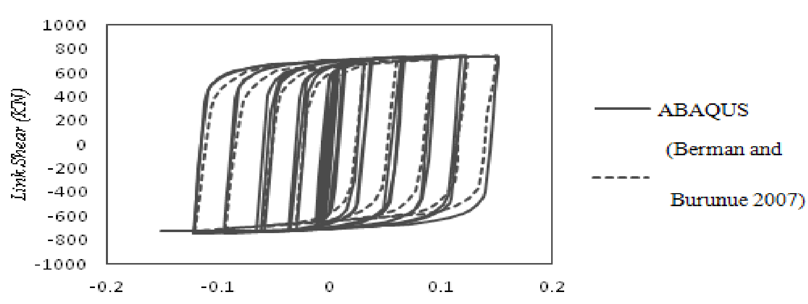

Figure 1. Comparison of the model built in ABAQUS and the experimental results of Berman and Bruneau

Table 1 gives rotation capacity of the link beams with tubular and I-shaped cross-sections for different values of flange compactness ratio, web compactness ratio and normalized link beam length (p).

Table 1. Stiffener spacing and rotation capacity of the link beams

Section	$\frac{b'}{t_f}$	$\frac{d'}{t_w}$ (T)	$\frac{d'}{t_w}$ (I)	γu (rad) ρ=1.2		γu (rad) ρ=1.6		γu (rad) ρ=2.1		γu (rad) ρ=3	
				(T)	(I)	(T)	(I)	(T)	(I)	(T)	(I)
S1	8	12	6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S2	8	16	8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
S3	8	24	12	0.2	0.2	0.2	0.2	0.2	0.2	0.16	0.2
S4	17	12	6	0.2	0.2	0.2	0.2	0.2	0.2	0.066	0.2
S5	17	16	8	0.2	0.2	0.2	0.2	0.11	0.2	0.057	0.2
S6	17	24	12	0.2	0.2	0.2	0.2	0.2	0.2	0.041	0.2
S7	24	12	6	0.2	0.2	0.093	0.2	0.082	0.2	0.04	0.047
S8	24	16	8	0.2	0.2	0.082	0.2	0.05	0.2	0.03	0.046
S9	24	24	12	0.2	0.2	0.11	0.2	0.039	0.2	0.021	0.044

It can be concluded from Table 1 that, if link beams with various cross-sections have geometrical similarity, I-shaped link beams will have approximately two times more rotation capacity than tubular link beams and it will be more significant with increasing of flange compactness ratio and link length. Figure 2 shows the link shear versus link rotation hysteresis curve for S7, ρ=2.1

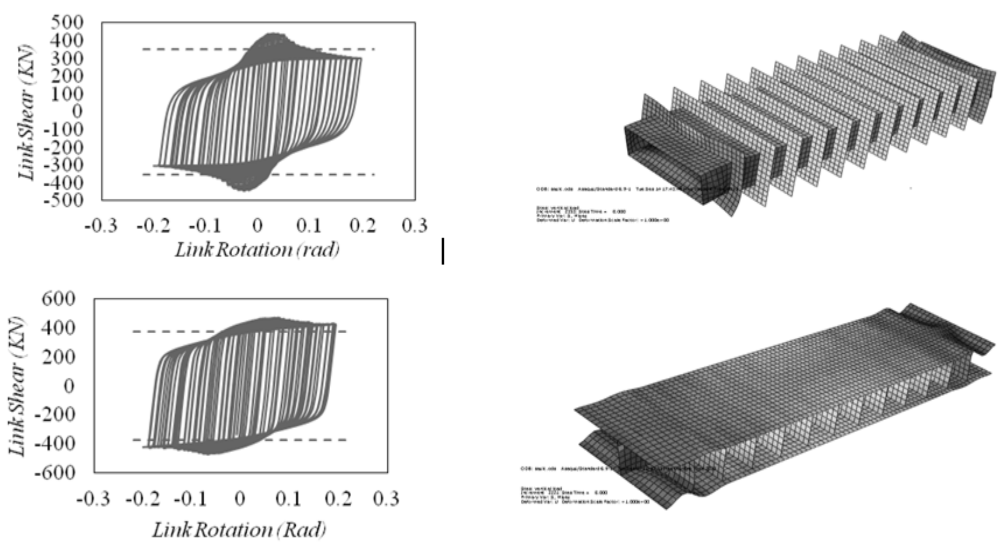

Figure 2. Deformed geometry and the link shear versus the link rotation hysteresis curve for s_7, ρ=2.1

This preference is because of the better performance of I-shaped link beams' web comparing to tubular link beams' web. In I-shaped link beams, both sides of the web is surrounded from up and down by flanges and from around by stiffeners, leading to creation of clamped boundary conditions around the web. But in tubular links, one side of the web is surrounded from up and down by flanges and from around by stiffeners. In this state, simply supported boundary conditions are created around the web. Clamped boundary conditions in around of I-shaped link beams' web cause delay local buckling and achieve more rotation that this preference is more significant in long I-shaped link beams.

Also it can be concluded from Table 1 that flange compactness ratio has more impact on the rotation capacity of tubular links, in a way that for one web compactness ratio, with increasing of flange compactness ratio, the rotation capacity decreases significantly that this decreasing is approximately 69%, but for one flange compactness ratio, with increasing of web compactness ratio, the rotation capacity decreases low that this decreasing is approximately 36% .

REFERENCES

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