Reduced Web Beam Section on the Stiffness of Moment Frames

Yousef Ashrafi[1], Behzad Rafezy[2], Behzad Azarm[3]

1-Msc , Sahand University of Technology
2- Assistant Professor, Sahand University of Technology
3- Msc Student, Sahand University of Technology
y_ashrafi@sut.ac.ir
rafezyb@sut.ac.ir
behzad_azarm@yahoo.com

Abstract

This paper presents the development of a non-prismatic beam element for modeling the elastic behavior of steel beams with reduced beam section connections. The closed form stiffness matrix of a two-dimensional frame element with a radius symmetric web reduction is developed using virtual work considerations. Also results of parametric studies conducted on beam cantilever and six-story two-and three-bay moment frames subjected to seismic base shear are also presented and results compared with the results of finite-element method.

Keywords: stiffness, finite element method, RBS connections.

1. INTRODUCTION

Before the Northridge earthquake on the 17th of January 1994, welded steel moment resisting frames (SMRF's) were widely used in seismic zones of the USA. The fully welded beam to column connection was used not only because of its economic and versatile nature, but because it was assumed that the connection would possess a high plastic deformation capacity. In the period following Northridge, this assumption was proven to be wrong, since brittle cracking of the welded beam-column connections was widely observed. The Reduced Beam Section (RBS) connection was developed to overcome such problems and provide fully seismic-resistant steel moment connections. Although considerable research and testing has subsequently been carried out, some potentially important aspects of the connection have not been thoroughly investigated. One of these aspects is the effect of the reduced web beam section on the elastic stiffness of the frame. An earlier study on flange reduction [1] indicated that an increase of around 10.6% in elastic story drift was likely due to a 40% flange reduction in the beam section. However, a more recent study [2] showed that the elastic story drift due to the same flange reduction was increased by only about 6%. Reducing or reinforcing a beam section will decrease or increase the stiffness of the beam, respectively, and will therefore affect the stiffness of the entire structure, influencing its internal loads and displacements. The key to analyzing the stiffness of such a structure lies in developing the individual stiffness matrices for both the reduced and reinforced frame members. These stiffness matrices must now define non-prismatic members, but once established the method for quantifying both the elastic and inelastic performance of the structure is well known.

This paper therefore describes the development of the closed –form stiffness matrix for a prominent new moment resistant connection, the reduced web beam section with radius cuts Figure1.

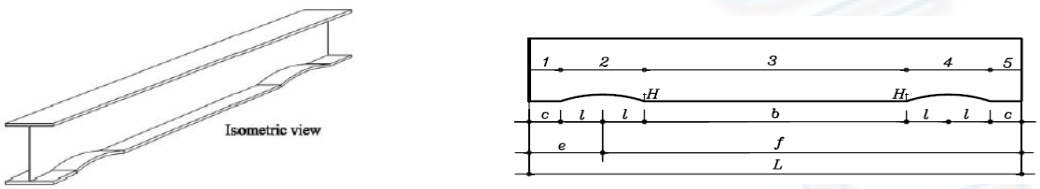

Figure1. Frame element with reduced web beam sections.