


# Chapter 4

## Built-Up Beam in Façade Engineering: Analysis of Shear Force and Bending Moment of Z- Section and I-Section

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### ABSTRACT

*Building structures must function according to façade engineering, integrating structural design with load analysis to ensure safe transmission of loads from facade and substructure to the primary structure while accommodating differential moments. To achieve efficient, strong systems, section modulus becomes crucial, particularly in primary and sub structural members of varied materials, where built-up beams play a vital role. This chapter analyzes structural behavior of different built-up beam designs for high-performance facades. Investigating properties such as center of gravity, moment of inertia, shear force, bending moment, bending and shear stresses enhances load-carrying capacity, material optimization, and adaptability to complex geometries. Further, connection strategies are evaluated for resisting wind loads*

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*and supporting cladding systems. Beam modeling and FEA help assess stresses and optimize cross-sections for stiffness and strength, strengthening the role of built-up beams in façade engineering for durable and impactful structural integration.*

## INTRODUCTION

The built-up beams are made from two or more pieces of material joined together to form a single beam. Such beams can be constructed in a great variety of shapes to meet special architectural or structural needs and to provide larger cross-sections than are ordinarily available.

As illustrated in Figure 1, typical cross-sections of built-up beams include wooden box beams, glulam beams and plate girders.

*Figure 1. Cross-sections of typical built-up beams: (a) Wooden box beam, (b) Glulam beam, (c) Plate girder*

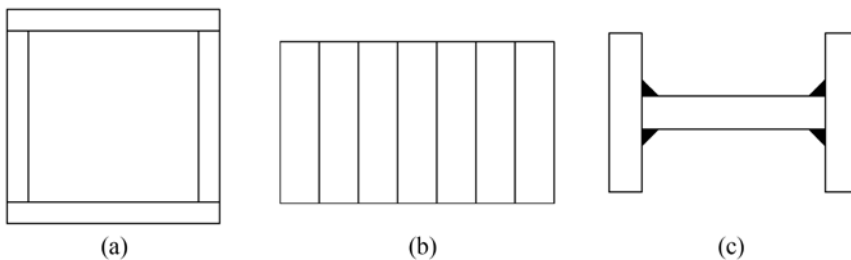


Figure 1(a) shows a wood box beam constructed of two planks, which serve as flanges, and two plywood webs. The pieces are joined together with nails, screws or glue in such a manner that the entire beam acts as a single unit. Box beams are also constructed of other materials, including steel, plastics and composites.

Figure 1(b) is a glued laminated beam (called a glulam beam) made of boards glued together to form a much larger longer beam than could be cut from a tree as a single member. Glulam beams are widely used in the construction of small buildings.

Figure 1(c) is a steel plate girder of the type commonly used in bridges and large buildings. These girders, consisting of three steel plates joined by welding, can be fabricated in much larger sizes than are available with ordinary wide flange or I-beams.

Built-up beams must be designed so that the beam behaves as a single member. The design calculations involve two phases. In the first phase, the beam is designed as if it is made up of one piece, taking into account both bending and shear stresses. In

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