A Slender Transparent Glass Supported High-Strength Steel Column

H.H. (Bert) SNIJDER
Professor, Eindhoven
University of Technology,
Eindhoven, The Netherlands
h.h.snijder@tue.nl

D. (Dennie) Dierks
Structural Engineer,
Volantis,
Venlo, The Netherlands
d.dierks@volantis.nl

E.M.P. (Edwin) Huveners
Structural Engineer,
Volantis,
Venlo, The Netherlands
e.huveners@volantis.nl

R.C. (Roel) Spoorenberg
Structural Engineer,
Iv Consult, Papendrecht,
The Netherlands
r.c.spoorenberg@Iv-Consult.nl

Summary

Modern architecture requires transparent and slender structural elements for columns. Usually, flexural buckling is the dominant failure mode of steel columns. If flexural buckling can be suppressed, the full yield stress may be utilized. Then, it makes sense to use high-strength steel. In this paper, a slender transparent glass supported steel high-strength steel column is designed, tested and numerically analysed. It consists of a 32 mm diameter Dywidag steel bar restrained against flexural buckling by four heat strengthened float glass panes, thus having sufficient redundancy allowing for a glass pane to break without column failure. The glass panes are connected to the steel bar by sliding steel sleeves avoiding direct stresses due to axial column deformation to occur in the glass panes. The column is one story high with slightly shorter glass panes keeping them free from roof and floor. The paper shows the feasibility of the glass supported high-strength steel column.

Keywords: glass panes, high-strength steel, column, flexural buckling, redundancy, epoxy adhesive bonded joint, finite element analyses, experiments.

1. Introduction

Several research projects have been carried out to investigate glass columns to achieve transparency paying special attention to structural safety by taking the brittleness of glass into account. Overend [1] investigated cruciform and tubular glass columns. Nieuwenhuijzen [2] investigated laminated tubular glass columns. Both research projects concluded that the end connections are essential elements for proper load introduction. Luible [3] investigated stability effects on small slender glass elements. Structural steel allows for slender columns but then flexural buckling is the dominant failure mode reducing the load bearing resistance. Roebroek [4,5] investigated a slender steel column in normal grade steel, laterally supported by a locally connected glass pane, to show that flexural buckling can be fully suppressed effectively. His work calls for the use of high-strength steel. The present study [6,7] therefore focusses on the design of a glass supported high-strength steel column where flexural buckling is suppressed effectively so that the squash load of the steel column can be achieved taking full benefit of the high-strength steel properties. The structural response of the proposed glass supported high-strength steel column is examined by means of experiments and finite element (FE) analyses. Special attention is paid to the loss of one or more glass panes showing the glass supported high-strength steel column to have sufficient redundancy. Thus, a transparent glass supported high-strength steel column is obtained.

2. Design

The design of the glass supported high-strength steel column is shown in the Figs. 1 and 2. This column consists of a high-strength steel bar supported by glass panes which are connected through sliding sleeves to the steel bar. Heat strengthened float glass resists a higher maximum principal tensile stress than anneal float glass and offers more residual capacity then fully tempered float glass. Therefore, the four supporting glass panes in crucifix arrangement are made of heat strengthened float glass. Using four glass panes, two for each direction, allows losing one glass

https://doi.org/10.2749/222137814814068265
Distributed by structurae