University of Vermont

CEE 3700: Structural Analysis

Dr. Eric Hernandez

Tabarik Abdulsalam & Stites Allen

UVM Gutterson Parking Garage

May 7, 2024

To: Dr. Eric M. Herandez

From: Tabarik Abdulsalam & Stites Allen

Subject: Structural Analysis of UVM Gutterson Garage

Date: 5/7/2024

Dear Dr. Hernandez,

As requested, a structural analysis was performed on a typical section of the Gutterson Garage. The section included an Internal column with a girder and double-Tee laying on it. The loads included in this analysis are Dead load (D), live load (L), snow (S) and seismic (E). Static calculations were used to find support reactions, connection forces, shear, axial and bending moment diagrams and maximum deflections for all load cases and load combinations. The load combinations used are recommended by ASCE7-10. All ground supports were considered rigid, while Girders and floor slabs were considered simply supported. The weight of the concrete used in this building is 145 lb/ft^3 with an Elastic Modulus of 3,500 ksi. The steel reinforcement was ignored in the calculations of moment of inertia.

Sincerely,

Tabarik Abdulsalam & Stites Allen

Introduction

The Gutterson Parking Garage is found on UVM's athletic campus in Burlington, VT. The garage serves as parking for many athletic facilities as well as commuters during school hours. The structure is two stories tall, spans 417 feet by 221 feet, and provides three levels of parking.

Figure 1: Gutterson Parking Garage

Load Path

Figure 2: Double-Tee to Girder Connection
Figure 3: Girder to Column Connection via Corbel

Dead Load: One internal column's dead load includes the weight of three double-tees, one girder, and the column itself for each floor of the garage. The weight of each double-tee is carried by the span of the girder and then the weights of the double-tees and girder are applied into the column via the corbels.

Live Load: The live load acting on one internal column includes the factored live load of three double-tees. The live load on each double-tee is carried by the girder's span into the column via the corbels.

Snow Load: The snow load acting on one internal column includes the factored snow load of three double-tees. The snow load on each double-tee is carried by the girder's span into the column via the corbels.

Seismic Load: The seismic loading acting on one internal column is a factored load governed by the total tributary weight acting on the column. The weight is equivalent to the dead load acting on two floors.

Load Analysis

Given Load**:**

Self-Weight of Concrete:	145 lb/ft^3
Modulus of Elasticity of Concrete:	3,500 ksi
Factored Live Load:	50 psf
Factored Snow Load:	40 psf

Double-Tee**:**

Girder:

Column**:**

Figure 4: Tributary Area of Interior Column

(3 Double-Tees, 1 Girder)

Summary of Load Analysis

The Dead load of the building including Double Tee, Girder, and the column will all be supported by the column. The live load will be applied on the double tee and girder for two floors. The Column will also support this live load on both floors. Snow load will only be applied on top of the second floor then transferred to the column. All these loads are axial loads acting downward. Seismic loads will be applied horizontally on the top of the two floors and will be pushing the column to the right at the points of connection.

Table 1: Double-Tee Load Summary

Double Tee				
Load Type	UDL (lb/ft)	Max Shear (Kips)	Max Bending Moment (Kip ft)	Total deformation (in)
Dead	821	22.5775	310.440625	0.713127566
Live	600	16.5	226.875	0.521165091
Snow	504	13.86	190.575	0.437778676

Table 2: Girder Load Summary

Girder				
Load Type	UDL (lb/ft)	Max Shear (Kips)	Max Bending Moment (Kip ft)	Total deformation (in)
Dead	5144.199	86.57686917	728.5443541	0.297776893
Live	2941.1764	49.49999881	416.54249	0.170252817
Snow	2470.588	41.57999604	349.8956667	0.143012356

Table 3: Column Load Summary

Column								
Load Type	Load (Kips)	Max Shear (Kips)	Max Bending Moment (Kip ft)	Total deformation (in)	Y-Support Reaction (Kips)	X-Support Reaction (Kips)	M-Support Reaction (Kip ft)	Axial deformation (in)
Dead	363.663	N/A	N/A	N/A	363.663	N/A	N/A	0.03501657
Live	198.0	N/A	N/A	N/A	198.0	N/A	N/A	0.019065126
Snow	166.32	N/A	N/A	N/A	166.32	N/A	N/A	0.016014706
Seismic	29.08	29.08	-533.28	0.767	N/A	-29.08		N/A

Table 4: Load Combinations

Load Combinations				
Load Combination	1.4 D	1.2 D + 1.2 L	1.2 D + L + 1.6 S	**Max**
Member	**Shear Forces (Kip)**			
Double-Tee	31.6085	46.893	65.769	65.769
Girder	121.2076168	163.2922416	219.9202355	219.9202355
Member	**Bending Moments (Kip-ft)**			**Max**
Double-Tee	434.616875	644.77875	904.32375	904.32375
Girder	1019.962096	1374.104213	1850.628782	1850.628782
Member	**Deflection (in)**			**Max**
Double Tee	0.998378592	1.481151188	2.077364051	2.077364051
Girder	0.41688765	0.561635652	0.756404858	0.756404858
Column	0.049023199	0.064898036	0.08670854	0.08670854
Connection	**Connection Forces (Kips)**			**Max**
Double-Tee to Girder	31.6085	46.893	65.769	65.769
Girder to Column	121.2076168	163.2922416	219.9202355	219.9202355
Support	**Support Reactions (Kips)**			**Max**
Column on Ground	509.1282	673.9956	900.5076	900.5076

Calculations

Double-Tee: Area, Centroid, and Moment of Inertia calculation for cross-section
Girder: Area, Centroid, and Moment of Inertia calculation for cross-section
Column: Area, Centroid, and Moment of Inertia calculation for cross-section

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