Barnstead Elementary School Addition

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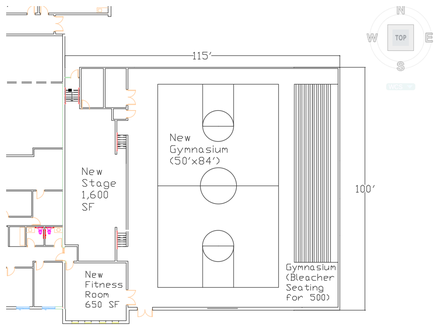
Introduction

Barnstead Elementary School, located on a 21-acre lot at 91 Maple Street, Center Barnstead, New Hampshire, serves as the town's only public school, educating students from kindergarten through 8th grade. This project involves expanding the Barnstead Elementary School with a new 12,000 SF gymnasium and associated site improvements.

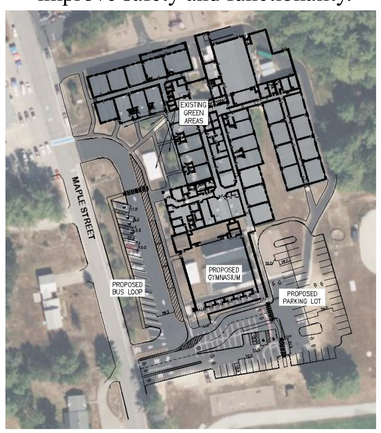
Proposed Gymnasium Addition

The structural scope includes designing a roof framing system for the gym, while the geotechnical component focuses on foundation design to accommodate this new addition.



Proposed Site Improvements

The site design addresses critical upgrades such as expanding the faculty parking lot, redesigning the bus loop, and resolving grading and drainage challenges to improve safety and functionality.



Structural

Open Web Bar Joist Selection

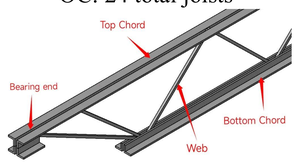
56DLH15

Chosen due to their structural efficiency, cost effectiveness, and ability to span long distance

Total Capacity: 747 plf which exceeds governing load of 695.5 plf

Deflection Check: $\Delta_{allowable} = \frac{L}{360} = 3.33''$

Spanning 100' along the 115' wall spaced 5' OC: 24 total joists



Load	Psf	Tributary Width (ft)	Plf
Snow Load	66	5	330
Wind Load	32.56	5	162.8
Roof Live	20	5	100
20-gauge 3615 metal decking, Insulation, Roof Membrane	4	5	20
56DLH15	__	__	42

Governing Load:

$1.2D + 1.6(Lr\ or\ S\ or\ R) + (L\ or\ 0.5W) = 695.65\ plf$

Column Selection

Effective Length: 26'

Worst Case Scenario Tributary Width: 20 feet

Column Capacity: Greater than153 kips

HSS 7x7x1/2:

Design Capacity of 186 kips

Nominal Weight: 42.05 plf

Area: 11.6 in^2

14 columns needed to support joists

Beam Selection

$Mmax = \frac{wL^2}{8} = 385\ kip - ft$

where w=7.7kip/ft, L=20feet

Allowable Stress: 30 ksi

W21x83:

Sx=171 in^3

(6) Beams total along 115' wall:

(5) 20 foot, (1) 15 foot

Deflection Check:

$\Delta_{allowable} = \frac{L}{360} = 0.66\ inches$

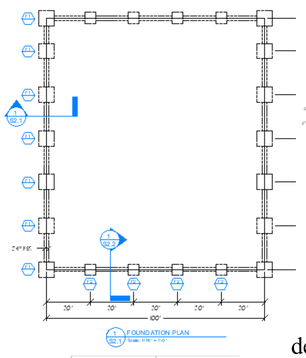
$\Delta_{max} = \frac{5wL^4}{384EI} = 0.29\ inches$

Geotechnical

Footing Calculations	
Factor of Safety, FS	2.5
7'x7'x2' Isolated Footing Design Capacity	354.6 Kips
2'x13'x2' Strap Beam Design Capacity	91.3 Kips
Total Design Capacity	445.9 Kips
Column Load	153 kips
Friction Angle ϕ_P	30°
Unit weight of soil, γ_m	111 pcf
Depth of Water, Z_w	14 ft

$$qbL^{net} = q_o\left(N_q S_q d_q - 1\right) + \frac{1}{2}\gamma B N_\gamma S_\gamma d_\gamma$$

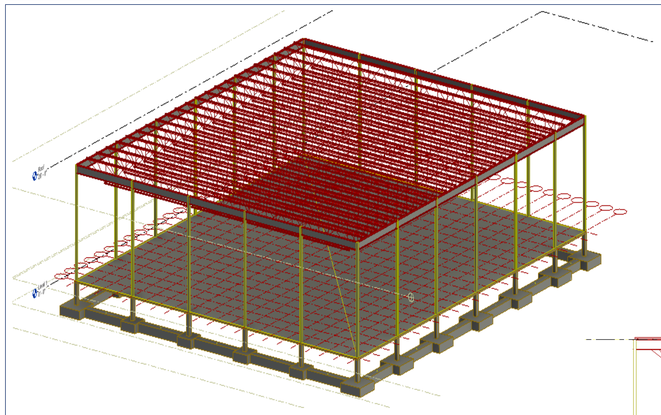
The equation to determine the ultimate bearing capacity for shallow foundations, modified with correction factors, is shown above.



Mark	Size
F1	7'x7'x2'
F2	5'x5'x2'

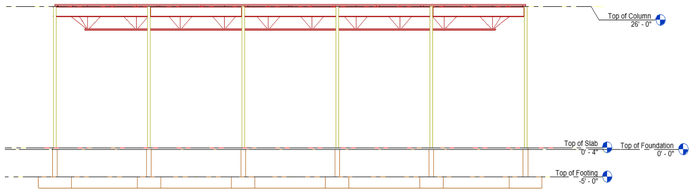
The load of 153 kips acting on each column design load of 382.5 kips considering a Factor of Safety of 2.5, was used to design the footings. S2.1 is a section view of F1, 7'x7'x2' and S2.2 is a section view of F2, 5'x5'x2'

Final Design

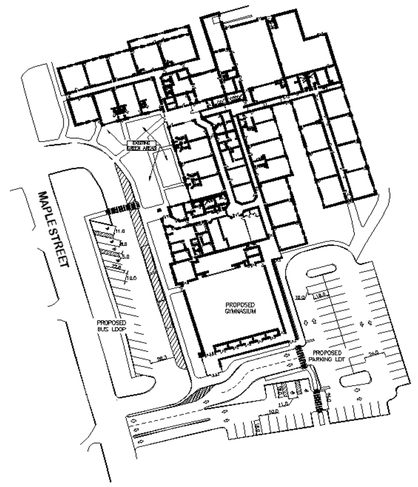


The drawing to the left shows the roof framing plan along with the foundation plan. The roof structure is comprised of 24 56DLH Series open web bar joists spanning 100 feet, supported by 14 HSS 7x7x1/2 columns. A beam support system of 6 W21x83 sections were designed to span between columns. The 115-foot wall, is segmented into (5) 20-foot sections and (1) 15-foot section. The foundation design system selected is a strap footing system, consisting of (14) 7'x7'x2' footings, (8) 5'x5'x2' footings, and strap beams that are 2'x2' but vary in length.

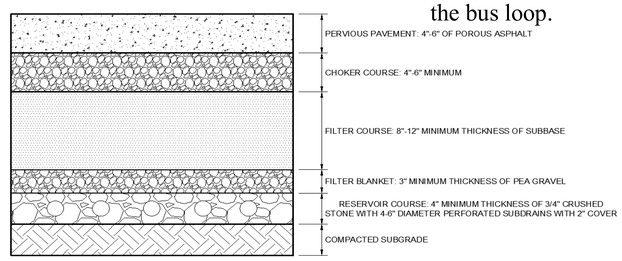
The drawing to the right is a section view of the gymnasium, showing the column, joist and foundation system.



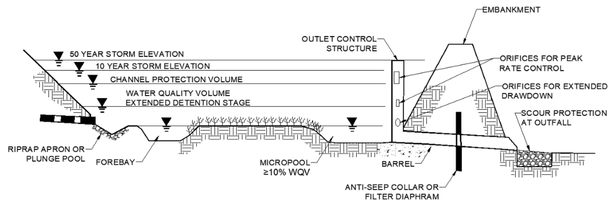
Site Design



- This new design separates the parking lot from the bus loop, including 80 parking spaces, six that are ADA compliant.
- The bus loop has been redesigned for bus drop-off access only, with restriped stalls to improve efficiency and ease of movement for buses.
- A dedicated vehicle drop-off/pick up area has been incorporated into the parking lot to prevent congestion in the bus loop.



- The bus loop consists of impervious pavement while the parking lot utilizes pervious pavement. As shown above, this system incorporates multiple layers to provide structural stability, hydrologic management, and water quality improvements
- During a 100-year, 24-hour storm event, the pervious pavement alone will absorb all stormwater within 13 hours



Above is a typical extended dry detention pond with a micropool profile. The proposed detention pond will mitigate flood risk through controlled stormwater storage and gradual release, while a micropool will enhance pollutant removal

Acknowledgements

The project team would like to thank our sponsor, The H.L. Turner Group, our Faculty advisor Dr. Azam and other faculty consulted along this project

References

- New Hampshire Stormwater Manual Volume 2
- NOAA Atlas 14
- AISC Manual 16TH Edition