Executive Summary

The following report describes the overall structural system of the Brunswick School Athletic Building. It includes loading summaries, some design checks of gravity and lateral load supporting members, as well as commentary on these calculations. Overall it was determined that either some addition loading should be taken into account, or designs were very conservative. It is probably more correct to assume that the discrepancies were due to missed or overlooked loadings.
Overall Structural System

As shown on the first floor plan, A-1, and the section at the ice rink, A-4, it can be seen that this structure is almost entirely composed of load bearing reinforced, fully grouted concrete masonry. Nearly all exterior walls are 12” CMU, with exception to the north wall of the ice rink which is 10” CMU. Minimum reinforcement in the 12’ walls is #6@24” and in 10” walls is #5@24” rebar. The height of these walls varies by grade level. The tallest is 29’ feet at the north side of the ice rink. Where the wall is below grade, a solid cast-in-place retaining wall is used. The CMU walls are at most 35’ long and are broken up by solid concrete piers for lateral support, see A-5. These piers also serve as bearing for the 105’ spanning glulam roof trusses. The load from the roof is transferred to the ground through the piers and into large pier footings, up to 7’x7’.

The central core or “brain” of the building has 3 stories. The top mechanical mezzanine consists of 4” concrete on metal deck, supported by steel W shapes spanning 21’-9”. These beams rest on W12 and TS12 columns that pass down to CMU walls of the first floor. The middle floor, where squash courts are located, has hollow pre-cast concrete planks of various thicknesses, bearing into CMU walls and utilizes W beams over wall openings.

All structural steel complies with ASTM A572 Grade 50 (fy = 50ksi). All masonry has a maximum compressive strength of 2000 psi; mortar is type S; masonry reinforcement is Grade 60. All cast-in-place concrete should be 4000 psi, normal weight, with Grade 60 rebar.

The glulam trusses were designed and built by Unadilla Truss Co. to their own specifications. These specifications have not yet been acquired. Analysis of the trusses is based on noted assumptions and will be completed when specifications are attained.
Building Codes

The Athletic Building was designed in 1999 in accordance to the following codes and standards:

- BOCA, 1996.
- Building Code Requirements for Reinforced Concrete, ACI 318-89, American Concrete Institute.
- Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, American Institute of Steel Construction.

In determining wind and seismic loading for this report, UBC 1997 was used, as listed in the AE497c text, Design of Reinforced Masonry Structures (Taly). This reference was selected because of the dominance of structural reinforced masonry in the Athletic Building.
Framing

See Appendix for framing plans with sketches and notes.

Drawings included:
A-1: First floor plan
A-2: Shear Wall location
A-3: Second floor framing of core
A-4: Mezzanine framing
A-5: Section at ice rink
A-6: Section at core
A-7: Pier detail
Details of System

This building’s system consists of a wide range of materials which are traditionally designed using very different methods. LRFD methods were used to analyze the cast-in-place concrete and structural steel. All wood and masonry was designed with ASD methods. This combination of methods complicates load calculations by requiring two sets of loadings, one factored and one unfactored.

Shear load is carried to the ground by many square feet of concrete block wall. Locations of shear bracing are shown on A-2.

Control joints in masonry walls are located at each 270° connection, see A-2, and at each pier. This allows each 35’ section of wall to be considered pinned at its ends. The walls and piers are fully braced at their base by dowels poured with the footings. All footings are anchored into very rigid soil. The piers are assumed to be fully supported against buckling by the CMU walls on each side. The tops of the walls and piers are anchored to the roof by pin connections, thus any moment in the trusses is not transferred to the piers.

Steel framing in the core which supports the pre-cast planks over wall openings appears to be pinned at ends that do not have walls above and fixed where walls pass through the floor. All other framing is pinned on each end. See A-3 & 4.

Truss A consists of 8 ½” x 33” top chords and a 6 ¾” x 30 ¼” bottom chord which spliced with a steel cable for more tension strength. Trusses are spaced at most 35’ on center.
**Loads**

Material dead loads found in UBC 1997, per *Design of Wood Structures*, Breyer. Live loads per IBC 2000, all matching those used in existing design (BOCA 1996). Wind and seismic values per UBC 1997.

The Brunswick School is located in Greenwich, Connecticut, which falls in 80 mph wind speed and seismic 2A zone. Ground snow load in this region is 30psf.

By its 1:4.7 slope, the roof qualifies for 20 psf live load, which is disregarded in load combinations (Lr or S or R) because snow load is greater.

Class C soil supports the foundation, 2-3 tsf.

See Appendix for the following load calculations and sketches.
A-5: Snow
A-8&14: Roof loads, factored
A-9: Wind
A-10, 11: Seismic
A-17: Foundation Load Path, unfactored
Calculations

Structural calculations were performed on 3 types of steel framing members, the masonry wall on the north side of the ice rink, the concrete pier in that masonry wall, the footing to the pier, and the center truss above the ice rink. Assumptions were made regarding the load of the cupola in the roof (see A-5), the truss bottom chord (ignoring steel cable), and mechanical unit loads.

Results follow with commentary. See Appendix for calculations.

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Summary

It was determined in the Construction Conditions Report that much of this design was based on aesthetics, and economic value was hardly a consideration. This seems still to be the case, considering the materials chosen for the roof trusses and exterior. However, overall framing members are economically chosen. Calculations come near of chosen values, but seem to be off due to loading assumptions. Further research into loadings is required. Additional factors must be considered such as weight of chimneys, cupolas, basketball hoops and mechanical units. Viewing balconies over the weight room, ice rink, and basketball court should be considered. Snow drifting against dormer windows and cupolas seems to be taken care of by snow guards. Research into how these work is desired.