TOWN OF
BARRINGTON, NEW HAMPSHIRE

REPORT ON THE
FLOOR LOADING ANALYSIS AND IDENTIFICATION
OF LOAD-BEARING AND NON-LOAD-BEARING
WALLS FOR BARRINGTON ELEMENTARY SCHOOL

JUNE, 1989

Prepared by

Underwood Engineers, Inc.
25 Vaughan Mall
Portsmouth, New Hampshire 03801

Underwood
Engineers, Inc.

Civil · Environmental · Structural

25 Vaughan Mall, Portsmouth, New Hampshire 03801 603-436-6192

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June 9, 1989

Mr. Albert St.Cyr
Town Manager
Town of Barrington
Star Route
Barrington, New Hampshire 03825

Re: Report on the Floor Loading Analysis of Barrington Elementary School
Barrington, New Hampshire

Dear Mr. St.Cyr:

Enclosed please find five (5) copies of the above referenced report for your review and further action.

Please call me in case you need any clarification or have any questions.

Sincerely,

UNDERWOOD ENGINEERS, INC.

Reginald L. Boucher, P.E.
Project Manager

SKG:mhj
Encl.

CONTENTS

INTRODUCTION

The Barrington Elementary School was originally built as a single, two-storied rectangular block (South block), constructed in 1938 under the WPA program. Sometime between 1938 and 1965 an additional rectangular block, referred to as the North block, was added to the original building. The second floor of the North block was added in late 1965.

The original plans for the building (South block), as constructed in 1938, were not available from the Office of the State Archives or the Town. The achitectural drawings for the added second floor of the north block were obtained from the Town Office. However, no details regarding the first floor wall foundations or the existing structural framing plans for the North block were available from these architectural set of drawings.

The Town of Barrington retained Underwood Engineers, Inc. in May, 1989 to perform the following tasks for the structural evaluation of the existing building:

1) Prepare sketch plans of the first floors and second floors of the North and South blocks.
2) Identify load-bearing and non-load-bearing walls.
3) Provide floor loading analysis and define possible uses of the specific areas with maximum permissible uniformly distributed load per square foot.

The following evaluation has been based on the study of available architectural drawings and visual inspection of the building and floor system.

SKETCH PLANS

Four sketch plans of the school building showing walls, corridors, stairways and present usage of the rooms have been included as part of this report. These plans are drawn to a scale of 1/8" = 1' and information regarding wall sizes was obtained from relevant architectural drawings.

On the sketch plans, the walls have been marked as W1, W2, etc. The specific room areas have been identified as A1, B1, etc. The non-load bearing walls have been indicated by hatch lines. Walls without hatches are load bearing type.

STRUCTURAL DATA

North Block

Exterior walls on all four sides of the north block are 12 inche thick load bearing brick walls. These walls were checked for any possible settlement cracks or cracks due to overstress. Visual examination of the walls showed no signs of stress or foundation settlement. This also indicates that the actual bearing pressure below the wall foundation under the present level of dead load and superimposed load is less than the available soil bearing capacity.

Corridor walls of the north block at both first floor and second floor levels are designed as 4 inch thick load bearing type cinder tile walls, reinforced by 5" x 5" M16 columns placed at intervals of approximately 14'-6". Floor loads are transmitted by wooden joists to this 4" thick wall by means of a 10WF 29 size beam.

In addition to corridor walls, the interior walls adjacent to stair well of north block (W5 at first floor and W10 at second floor) are load bearing walls. Wall W5 consists of 10" thick cinder tile and wall W10 consists of 8" thick cinder tiles.

All other walls in the north block on both the first floor and the second floor levels are partition walls of a non-load-bearing type.

The flooring system for the north block are as follows:

A) First Floor: Concrete floor slab supported on grade. No details regarding the floor slab thickness or reinforcement are available

B) Second Floor: 3/4" thick plywood laid over approximately 3/4" additional wood board flooring supported by wood joists spaced at 12" o.c.

C) Roof: Flat roof with 20 year bonded built-up roofing over light weight concrete fill and 2" thick Insulrock supported by steel joists.

South Block

Exterior walls on all four sides of the south block are also 12 inch thick load bearing brick walls. Visual inspection of the walls indicated no signs of cracks due to settlement or overstress. All other load bearing and non-load-bearing walls are specifically indicated on the floor plans. However, details pertaining to construction material of the corridor or stairway walls are not available.

The flooring systems for the south block are as follows:

A) First Floor: Concrete floor slab supported on grade. No data on thickness of slab or reinforcements are available.

B) Second Floor: Approximately 1" thick wood flooring over 2" thick concrete floor reinforced by wire mesh. The floor system is supported on a grid of rolled channel and I-sections. The average span of concrete flooring is approximately 3 feet.

C) Roof: Sloped roof with shingles supported on wood rafters, wood purlins and steel trusses comprising of rolled steel angles.

FLOOR LOAD ANALYSIS

The computations for determination of maximum permissible floor loads are included at the end of the report. Based on the results of computations, safe superimposed load limits and possible usage of floor areas have been recommended. The design live loads for various types of occupancies are also furnished at the end of the report.

The exact thickness and reinforcements for the slabs on grade were not available. Visual inspection of the slabs on grade showed no settlement or stress cracks. Slabs on grade are designed to resist uplift pressure and superimposed loads and act as a counterweight to reduce warping, uplift and top cracking failures. Based on the present level of loads, the existing slab on grade should safely carry uniformly distributed superimposed loads up to 150 pounds per square foot (PSF).

RECOMMENDATIONS

1) North and South Blocks: Slab On Grade

Use first floor area for all superimposed load intensities up to a maximum of 150 PSF. (Re: Appendix D, Minimum Design Floor Live Loads). These areas could be used to carry all heavy equipment loads, library, stack rooms, books and shelving, auditorium, storage, file room or similar purposes.

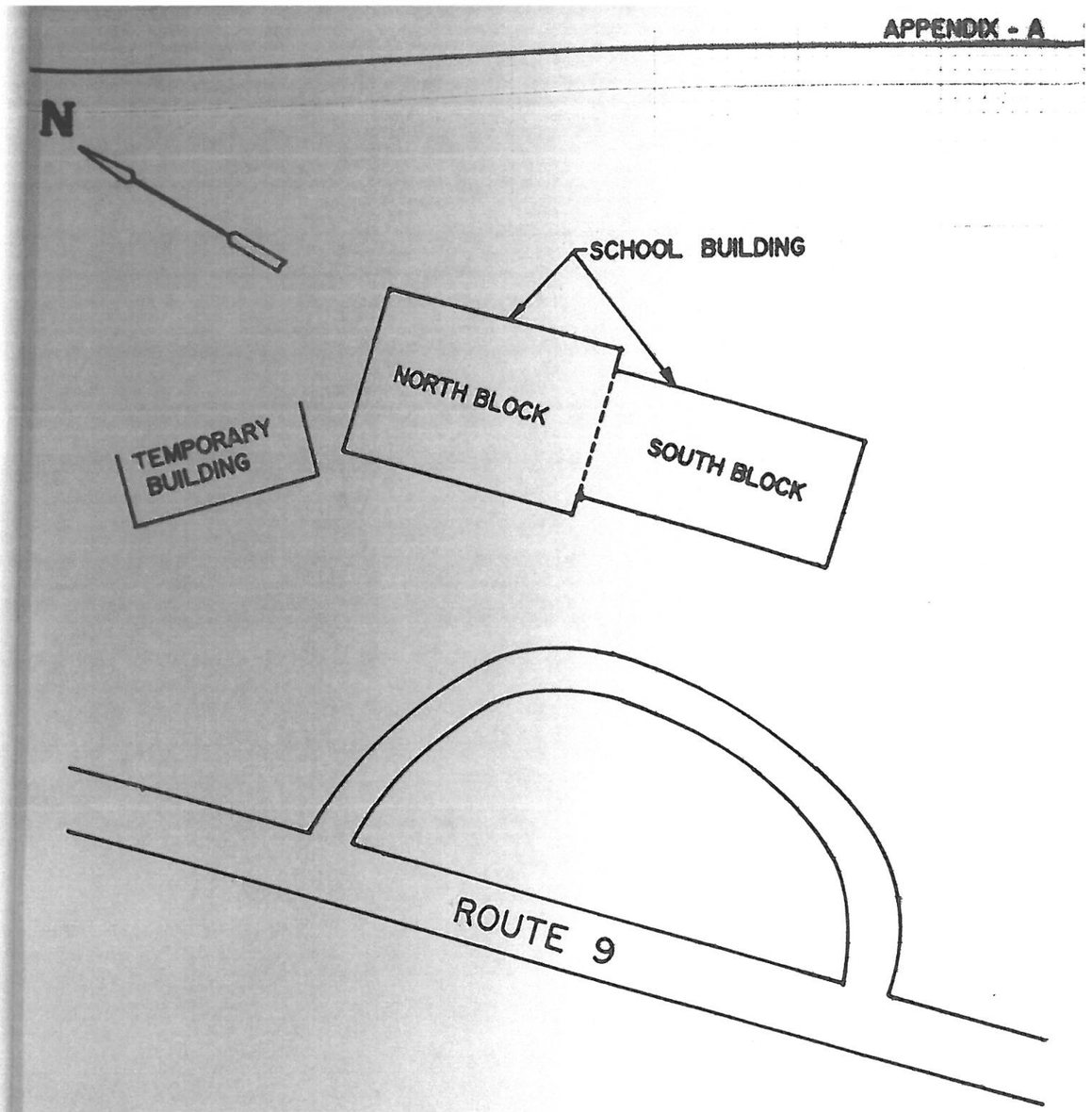
2) North Block: Second Floor

Use second floor classroom for all superimposed load intensities up to a maximum of 50 PSF. Examples of such uses are offices, rest rooms, hospital wards and rooms of similar purpose.

Use second floor corridor areas up to a maximum load intensity of 148 PSF. Uses include office file rooms, lobbies, wholesale stores, heavy equipment, etc.

3) South Block: Second Floor

Use entire second floor area up to a maximum load intensity of 45 PSF. Uses include hospital wards and rooms, school classrooms, restrooms, apartments, etc.



BARRINGTON ELEMENTARY SCHOOL

LOCATION PLAN

SCALE 1" = 50'-0"

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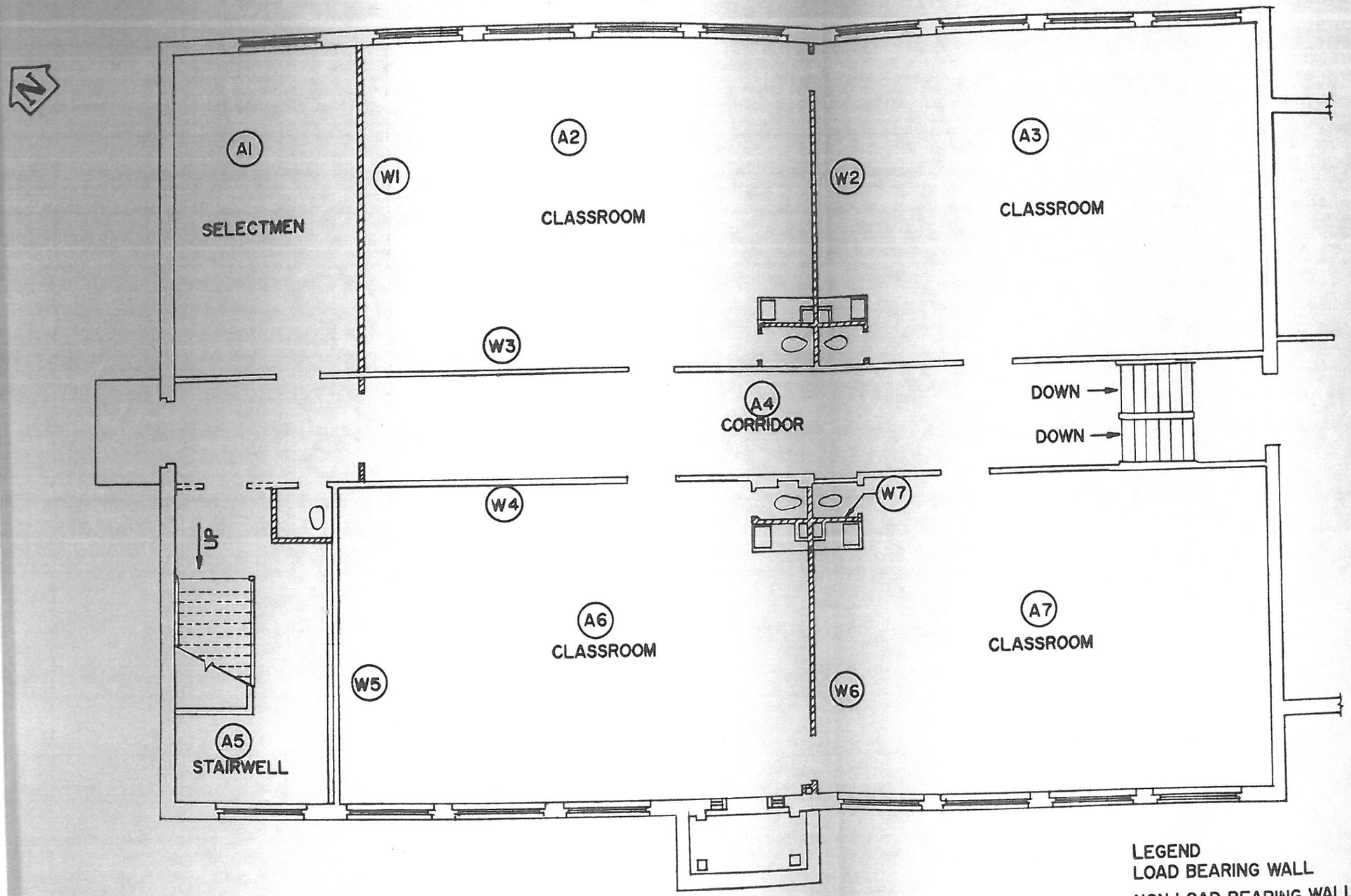

FIRST FLOOR PLAN - NORTH BLOCK

SCALE 1/8" = 1'-0"

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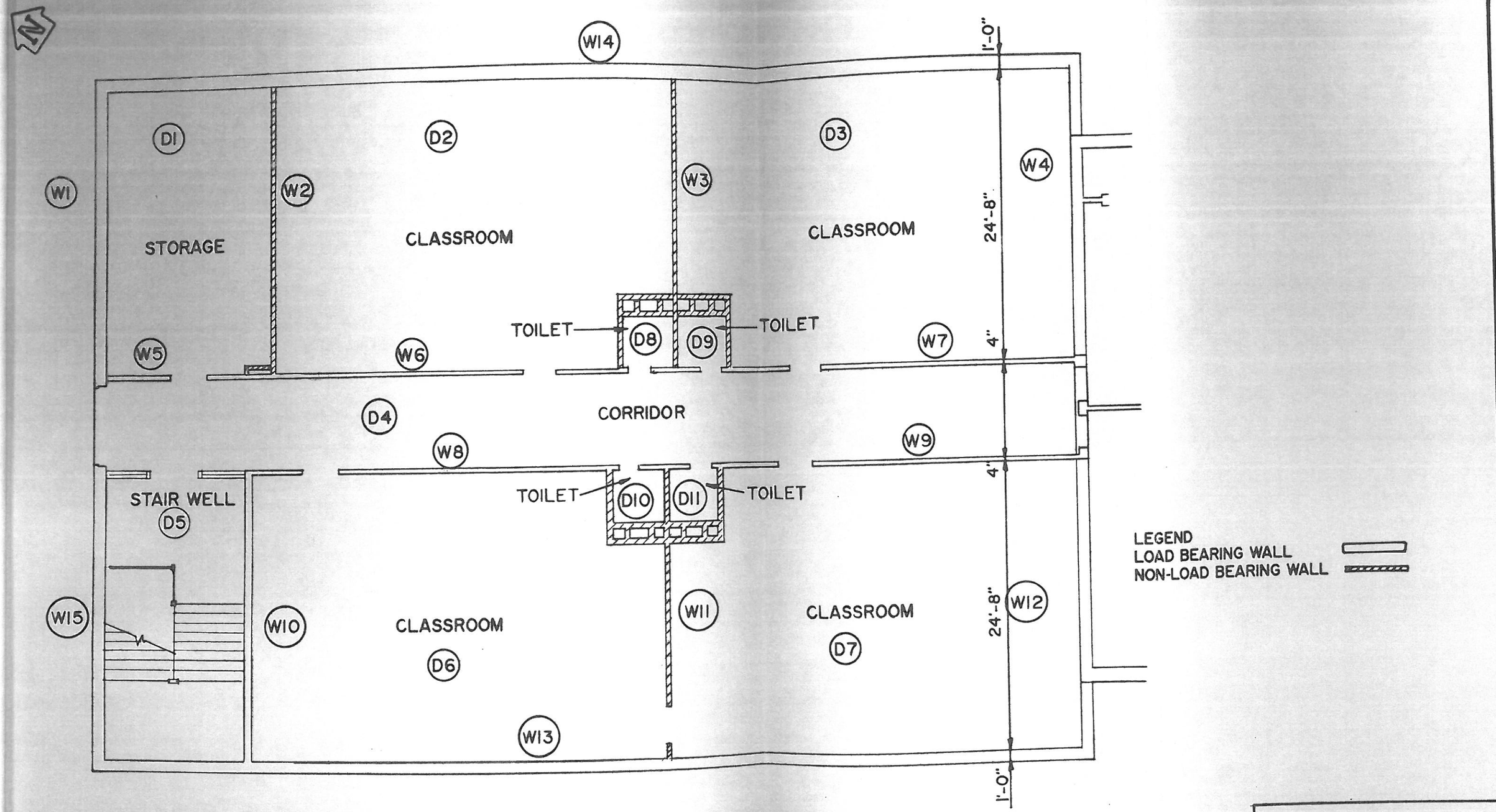

SECOND FLOOR PLAN - NORTH BLOCK

SCALE: 1/8" = 1'-0"

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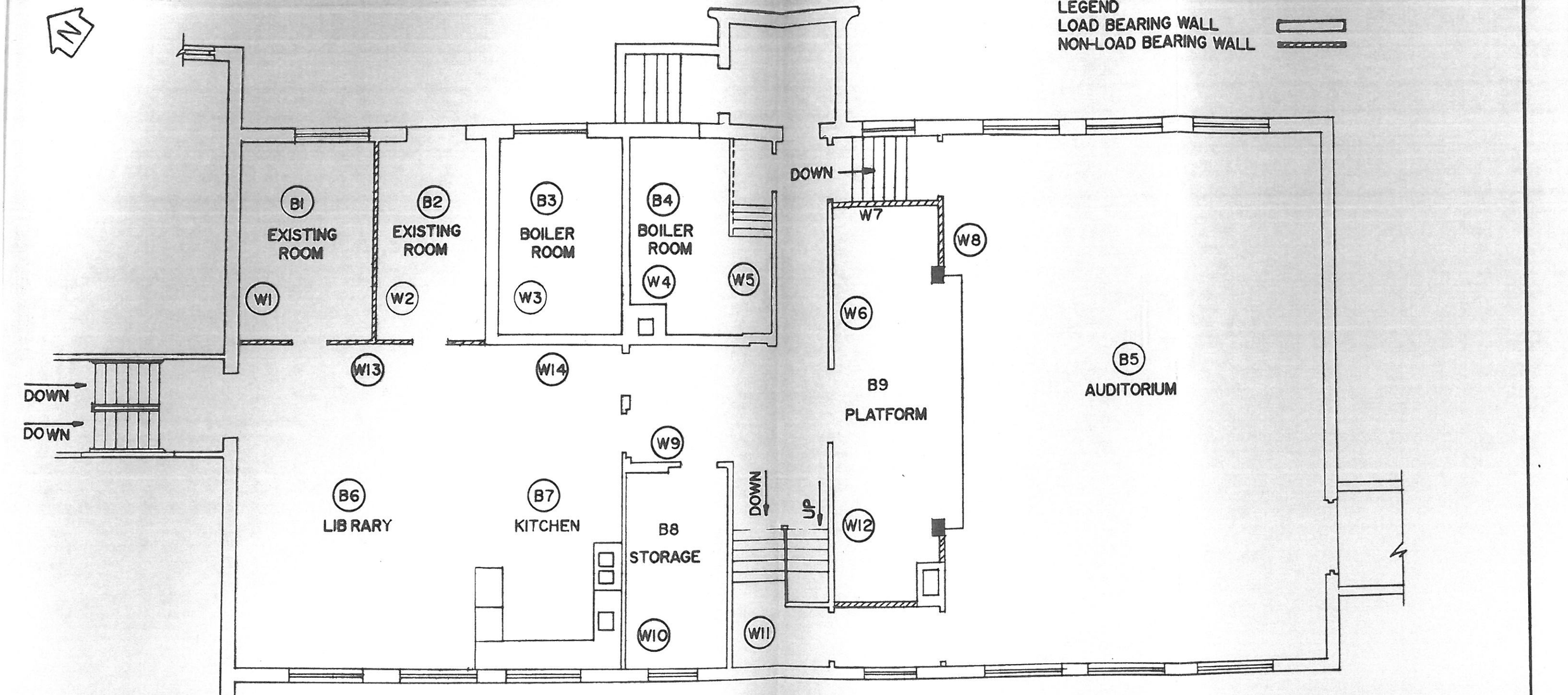

FIRST FLOOR PLAN
SOUTH BLOCK
SCALE 1/8" = 1'-0"

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LEGEND
LOAD BEARING WALL
NON-LOAD BEARING WALL

CLASSROOM C1
TOILET C2
C3
DOWN
W2
W3
TEACHER'S ROOM C4
W4
W5
W6
CLASSROOM C5
W7
1'-0"
22'-2-1/2"
3"
W1
CORRIDOR
C8
W10
W11
CLASSROOM C6
W8
C7
W9
UP
DOWN
C9
CLASSROOM C10
22'-2-1/2"
1'-0"

SECOND FLOOR PLAN - SOUTH BLOCK

SCALE 1/8" = 1'-0"

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JOB
SHEET NO. 1 OF 6
CALCULATED BY SKG DATE 6-2-89
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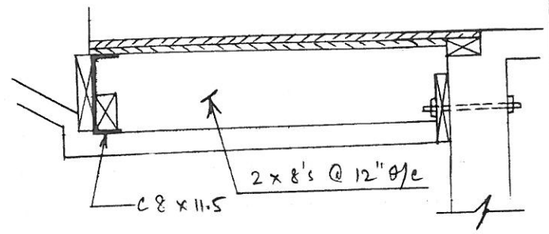
SCALE

NORTH BLOCK STAIRWAY FRAMING:

REFER SHT. 3 OF 5, SECTION AT STAIRS IN CORRIDOR NO. 106 AND EXISTING WALL AND FLOOR, ARCHITECTURAL SET OF DRAWINGS



SPAN = 5'-1".

ASSUME WOOD JOISTS OF THE FOLLOWING PERMISSIBLE LIMITS (SOUTHERN YELLOW PINE)

F_b = 1250 #/D"

F_v = 95 #/D".

E = 1400,000

FOR 2" x 8" JOISTS, S_{max} = 13.141 IN^3

∴ MOMENT CAPACITY = 13.141 x 1250

= 16426 #"

= 1369 #'

EQUIVALENT UDL = $W = \frac{8 \times 1369}{L^2}$

$= \frac{8 \times 1369}{(5.083)^2} = 424$ #/D' (MOMENT CONSIDERATION)

FROM SHEAR CONSIDERATION

$95 = \frac{3}{2} \times \frac{V}{bd} = \frac{1.5 \times (5.083) W \times 0.5}{1.5 \times 7.5}$

OR $W = \frac{95 \times 1.5 \times 7.5}{1.5 \times 5.083 \times 0.5} = 280$ #/D' (GOVERNS).

ACTUAL DEAD LOAD = 2.8# (JOIST) + 5# (BOARD) + 5# (INSULATION)

= 13 #/D'

LIVE LOAD = 100 PSF (STAIRWAYS).

∴ CAPACITY = 113# (REQUIRED) VS. 280 #/D' (ACTUAL).

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SCALE

NORTH BLOCK SECOND FLOOR FRAMING

EXISTING FLOOR FRAMING SYSTEM CONSISTS OF 2" x 14" WOOD JOISTS @ 12" o/c.

ASSUME SOUTHERN YELLOW PINE GRADE.

F_b = 1250 #/D". (CONSERVATIVE ASSUMPTION).

F_v = 95 #/D"

E = 1400,000 #/D".

SPAN = 24.67'

FOR 2" x 12" DEPTH JOISTS S = 43.891 IN^3.

WEIGHT = 4.8 #/D'

A = 19.875 D".

∴ MOMENT CAPACITY = 43.891 x 1250

= 54863 #" = 4572 #'

EQUIVALENT VDL. = $W = \frac{8 \times 4572}{(24.67)^2}$

= 60.10 #/D'.

FROM SHEAR CONSIDERATION

$95 = \frac{3}{2} \cdot \frac{V}{bd}$

$= \frac{1.5 \times (12.84) W \times 0.5}{1.5 \times 13.25}$

95 = 0.48 W OR W = 196.0 #/D'

∴ MOMENT CRITERIA GOVERNS

ACTUAL DL. = 4.8 + 3 # (BOARD) + 0.5 # (INSULATION)

= 8.3 #/D'

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∴ PERMISSIBLE LIVE LOAD
= 60.10 − 8.30 = 51.8 #/D'

LL CAPACITY = 51.80 #/D'

SCHOOL CLASSROOMS LL = 40 #/D'

∴ CAPACITY (LIVE LOAD) = 40 #/D' (REQUIRED)
VS. 51.8 #/D' (AVAILABLE)

NORTH BLOCK CORRIDOR AREA FRAMING:

EXISTING FLOORING CONSISTS OF 2"x 8" WOOD JOISTS SPACED AT 12" O/C.

SPAN OF JOISTS = 8'-4"

ASSUME WOOD JOISTS OF SOUTHERN YELLOW PINE WITH FOLLOWING PERMISSIBLE LIMITS:

F_b = 1250 #/D" (CONSERVATIVE)

F_v = 95 #/D"

E = 1400,000 #/D".

FOR 2" x 8" JOISTS

S = 13.141 (STRONG AXIS)

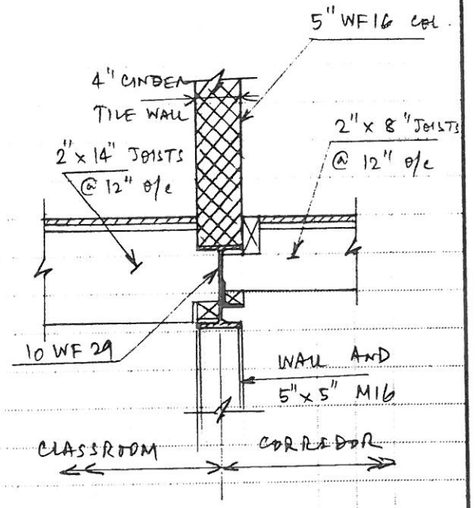
∴ MOMENT CAPACITY = 13.141 x 1250

= 16427 #"

= 1369 #'

EQUIVALENT UDL = $W = \frac{8 \times 1369}{(8.33)^2}$

= 158 #/D' > 50 #/D'



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JOB 489-02 BARRINGTON ELEM. SCHOOL
SHEET NO. 4 OF 6
CALCULATED BY SKG DATE 6-4-89
CHECKED BY DATE
SCALE

CHECK EQUIVALENT UDL FROM SHEAR STRESS CRITERIA

$$95 = \frac{1.5\,V}{bd}$$

$$= \frac{1.5 \times (8.33 \times W) \times 0.5}{1.5 \times 7.25}$$

OR $W = 165\ \#/\text{FT}$ VS. $158\ \#/\text{FT}$ (MOMENT CRITERIA)

ACTUAL DEAD LOADS ARE

JOIST = $2.6\ \#/\text{FT}^2$
3/4" BOARD = $3\ \#/\text{FT}^2$
MISCELLANEUS = $4.4\ \#/\text{FT}^2$ (SAY)
$10\ \#/\text{FT}^2$

∴ LIVE LOAD CAPACITY = $158 - 10 = 148\ \#/\text{FT}$ (ACTUAL)

REQUIRED LIVE LOAD CAPACITY FOR SCHOOL CORRIDOR IS

$W_{LL} = 100\ \#/\text{FT}. < 148$ GOOD.

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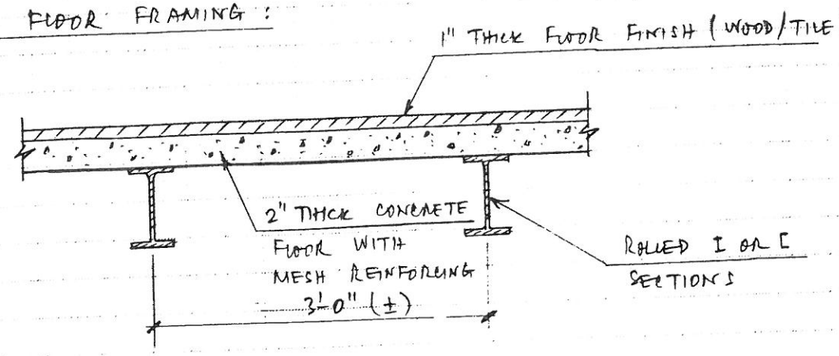
SOUTH BLOCK FLOOR FRAMING :



TYPICAL FLOOR SECTION

THE ACTUAL STRENGTH OF FLOOR CONCRETE AND MESH REINFORCING DATA ARE NOT AVAILABLE. THE FOLLOWING ANALYSIS IS BASED ON CONSERVATIVE ASSUMPTIONS OF 4000 PSI CONCRETE AND NOMINAL WIRE MESH REINFORCING OF GRADE 16 KSI

ASSUME ONE-WAY CONTINUOUS SLAB ACTION WITH ½" CLEAR COVER FOR REINFORCEMENT.

$M_{ACTUAL} = 359\ bd^2$ ✓ ($R = 359\ \#/IN^2$ ✓)

$= 359 \times 12 \times (1.5)^2$ ✓

$= 9693\ \#''$

$= 808\ \#'$

$M_{REQD} = \frac{W \times 3^2}{10} \times 12 = 10.8\ W\ \#''$ ✓

$\therefore\ W = \frac{808}{10.8} = 75\ \#/FT$ ✓

SUPERIMPOSED LOAD = 75 − 25 (CONCRETE) − BOARD (2.5)

= 47.5 PSF.

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SHEET NO 6 OF 6

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SCALE

DESIGN LIVE LOAD FOR SCHOOL CLASSROOMS IS 40 PSF.

∴ FLOOR LOAD CAPACITY = 47.5 PSF (ACTUAL) VS 40.0 PSF (REQUIRED).

MINIMUM DESIGN FLOOR LIVE LOADS*

OCCUPANCY OR USE	DESCRIPTION	UNIFORM LOAD POUNDS/SQ. FT.
Residential	Apartments	40
Schools	Classrooms	40
	Corridors	80
	Toilets	40
Office Buildings:	Offices	50
	Corridors	80
	Files	125
	Rest Rooms	50
Libraries	Corridors	80
	Reading Rooms	60
	Stack Rooms, Books and Shelving	125
Hospitals	Wards and Rooms	40
Lobbies	Floor	100
Gymnasiums		100
Manufacturing	Light	75
	Heavy	125
Auditorium	Fixed Seats	60
	Moveable Seats	100
Stores	Retail	75
	Wholesale	100
Stairs and Exitways		100

* Source: Uniform Building Code