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NORTH MEDFORD GYM COLLAPSE
MEDFORD, OR
STRUCTURAL EVALUATION

KPFF PROJECT NO. 10022500117

DATE
MAY 5, 2025

SUBMITTED TO

MEDFORD SCHOOL DISTRICT
680 BIDDLE RD
MEDFORD, OR 97504

SUBMITTED BY

KPFF CONSULTING ENGINEERS
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MAR. 10, 2009
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EXPIRES 12-31-2026

NORTH MEDFORD GYM COLLAPSE

STRUCTURAL EVALUATION

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EXECUTIVE SUMMARY

KPFF reviewed the common factors that can lead to structural failures and through our investigation and analysis have formed a professional opinion on whether they played no role, a minor role, or a major role in the beams' failures.

In our opinion, the main two contributors to the beam failures were:

- Scarf joint manufacturing and potential early delamination.
- Increased understanding of the structural capacity of deep glulam timber beams since the gym's construction which led to significant reductions in beam flexural capacity.

These two contributors led the roof glulam beams to be overstressed under the roof's total dead loads providing limited ability to support additional roof live or snow loads.

In our opinion, minor contributors included the event snow loads and the basketball hoop.

The seismic retrofit, other roof loads, and member decay were not found to be contributing factors.

It is also our opinion that the use of glulam beams in a low-slope roof (slope less than 15-deg) was, and still is, an appropriate choice to be used for a gymnasium with similar spans and loads.

A. PROJECT SCOPE

On February 7, 2025, a bending failure occurred in two glued laminated (glulam) beams in the main gym at the North Medford High School Gymnasium. Four days later, on February 11, 2025, three of the glulam beams completely collapsed and several hours later the remainder on the main gym roof collapsed. See Appendix A for a roof plan indicating the initial failed beams and main gym collapsed roof area.

KPFF has reviewed the existing structural drawings, seismic evaluation reports, seismic retrofit drawings and submittals, and a 3D scan of the pre-collapsed condition. We have reviewed video and photo documentation of the roof beams from initial failure to collapsed state. An onsite review of the partial building collapse and three failed beams was conducted.

B. GYM BUILDING DESCRIPTION

The North Medford High School gym was built in 1965 and is 192-ft. x 176-ft in size. The gym building included a main gym with a double height space, an auxiliary gym above the locker, team rooms and storage, and a weight room above the main lobby for the building.

The main gym is 112'-8" wide and 144'-8" long. The original roof was supported by 3x doug fir decking spanning between 4x14 nominal doug fir timber joists at 8'-0" o.c. The timber joists spanned to long-span tapered glulam beams spaced 16'-0" o.c. The long-span glulam beams were 11" wide, 60-1/8" deep a mid-span, and 46-1/8” deep at each end. The glulam beams spanned 112-ft to reinforced concrete columns or built-up steel girders at the north and south edge of the main gym. The columns are supported by reinforced concrete spread footing. The perimeter wall is partially grouted concrete masonry unit (CMU) wall.

The gym roof glulam beams are tapered to provide a roof slope of ¼” per foot sloping towards the north and south with ridge centered over the main gym.

Remodel and Retrofit Work

Since the building’s original construction, we understand there have been a few remodel and retrofit projects including a 2008 locker room refresh, a 2010 re-roofing, and a 2024 seismic retrofit.

No documentation has been received for the 2010 re-roofing project. Based on information provided by the seismic retrofit roofing contractor, it is understood that the roofing was 2-inches of rigid insulation covered by a roof membrane.

The 2024 seismic retrofit project reinforced the existing roof diaphragm, provided new perimeter shotcrete shear walls, reinforced interior CMU shear walls, and installed a new roof over the gym building.

C. BEAM FAILURES

It was first reported that Beam A cracked near mid-span on February 7, 2025. Review of photo and video documentation show the failure initiated near a scarf joint near mid-span at the bottom lamination. The crack propagated upward and north in a flat “V” pattern which is typical of a bending failure in wood beams. The first crack also extended north through one of the connections supporting the basketball hoop below.

Figure 1 – Beam A Initial Failure

Photos of Beam A's initial crack also show a hairline crack forming in Beam B. Beam B's crack also initiated at the bottom lamination at a scarf joint near mid-span.

Figure 2 – Beam B Crack

After Beam A and B collapsed on February 11, 2025, Beam C failed next in flexure and two hours later the entire main gym roof collapsed.

The collapse of the entire main gym roof was caused by a progressive collapse where damage in one member leads to overloading of nearby structural members. It is not standard practice to consider progressive collapse in the structural design for most buildings, including K-12 schools.

D. GLUED LAMINATED TIMBER BEAMS

This section evaluates the glulam timber beam's condition including design values, manufacturing, and decay to evaluate if they were a contributing factor in the roof glulam beam failures.

DESIGN VALUES

Since 1965, several changes have been made to the rules for assigning design values to structural glulam members. In the 1960's improved testing found that the tensile strength of lumber was significantly lower than previously assumed. The reduction in lumber tensile strength reduced the allowable design stresses for glulam timber stressed in bending.

As a result, the laminating industry adopted the use of AITC special tension lamination grades in 1970. AITC Tech Note 26 dated April 2023, recommends the reduction of bending design values by 25% for beams deeper than 15-inches where the use of special tension lamination grade is not used.

We have not been able to confirm if the AITC special tension laminations were used, therefore it is assumed the 25% reduction to the bending values would be applicable. Where access to three sides of the bottom two laminations of the glulam could be achieved, this reduction could be revisited.

Professional Opinion

The beams supported the required roof dead, live, and snow loads for a 60-year service life. The original design for the glulam beams, without the bending value reduction, placed the beam’s stress limit at about 90% of its capacity, which is a common stress limit for these types of building elements.

However, since the original design, more knowledge has been gained regarding the strength of tension laminations in glulam beams. The beams were originally designed assuming an extreme fiber bending stress, Fb, of 2,600 PSI, however with the recommended 25% reduction the allowable bending stress should have been Fb = 1,950 PSI. This information led to a significantly reduced factor of safety in the glulam roof beams from the original design.

See Section E for the beam member stress when also considering the reduced bending values and changes in wood code requirements.

It is our opinion that the reduced factor of safety, due to the change in design values due to overestimating of lumber tensile strength, was a contributing factor in the beam’s capacity to support the loads at the time of failure.

MANUFACTURING

Based on the original structural drawings, the glulam roof beams were to be built in accordance with “Standard Specification for Design and Fabrication of Structural Glued Laminated Lumber” of the West Coast Lumbermans Association and were identified to be Combination A.

Based on visual observation of the failed beams, the beams were manufactured using Douglas-Fir lumber with 1.5-inch net laminations and sloped scarf joints for individual lumber end joints. A scarf joint is a long-tapered cut on each timber piece which is then overlapped and glue laminated together to transfer tension and compression forces. See Figure 3.

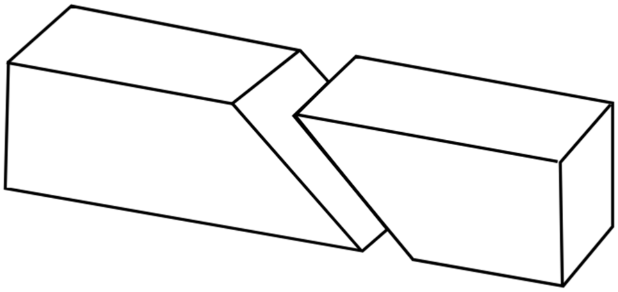

Figure 3 – Scarf Joint

Current code glulam manufacturing standards utilize finger joints for the lamination end joint. Finger joints were first introduced in 1962 and by the 1970s were the more common end joint in glulam timber structural members. See Figure 4.

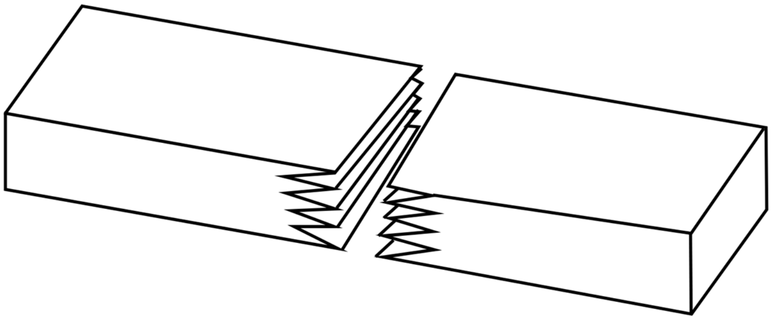

Figure 4 – Finger Joint

The gym roof glulam beams were visually observed for signs of manufacturing defects and delamination. A 3D scan of the entire gym was provided and reviewed to evaluate pre-collapse glulam beam conditions. Visual observation using photos and onsite review of members after demolition were also reviewed.

A video of the initial crack in Beam A appears to indicate that it originated at a location of a scarf joint in the bottom lamination. Photos of the initial crack in Beam B also exhibit similar signs. Review of the 3D scan of the pre-collapse gym appears to indicate a delaminated scarf joint in Beam B where the crack seen on February 8, 2025, appears to have originated.

Review of the collapsed beams on site after demolition and removal consistently showed relatively clean scarf joints that indicate poor glue lamination and bonding at scarf joints.

Figure 5 – Failed Scarf Joint

Professional Opinion

We reached out to experts in the field of glulam construction, and it is our understanding that laminating scarf joints is challenging and therefore it is not uncommon to find pre-maturely failed scarf joints in glulam beams from this time period.

It is our opinion that the manufacturing and delamination of the scarf joints for the glulam beams was a contributing factor in the beam's failure.

DECAY

The gym roof glulam beams were visually observed for potential signs of decay. A 3D scan of the entire gym was provided and reviewed to evaluate pre-collapse glulam beam conditions. Visual observation using photos and onsite review of members after demolition were also reviewed.

KPFF met with the Medford School District Facilities team to discuss past maintenance issues or potential damage to the roof. Based on these conversations, it is our understanding that the main gym roof did not experience any major water intrusion issues over its life span.

Three of the gym roof glulam beams which had initially failed were observed after they had been removed from the structure. Appendix B provides a plan identifying these beams in the gym in the pre-collapse. These elements were visually inspected, probed with an awl, and evaluated with a resistograph to determine the presence of decay. Images of the beams after removal were also taken.

Visual inspection found occasional staining of the glulam exterior; however, further investigation with an awl exhibited sound wood with no evidence of decay. The presence of exterior staining without further evidence of decay indicates temporary water intrusion.

Professional Opinion

It is our opinion that decay of the glulam beams was not present, and therefore not a contributing factor to the beam's failure.

E. WOOD DESIGN

This section evaluates the changes in wood design from the original construction of the gym to current code requirements to evaluate if changes to wood design since the original construction was a contributing factor in the roof glulam beam failures. Current Code is the 2022 Oregon Structural Specialty Code (OSSC) which is based on the 2021 International Building Code (IBC).

WOOD DESIGN CODE REQUIREMENTS

Wood design codes in the U.S. have evolved significantly since the 1960s.

Original Wood Construction Code Requirements

The existing structural drawings, dated December 13, 1965, indicate that the glulam beams were to *be built in accordance with "Standard Specification for Design and Fabrication of Structural Glued Laminated Lumber" of the West Coast Lumbermans Association.*

Although the existing drawings do not indicate a specific code, we reviewed the glulam timber design requirements identified in the "Standard Specifications for Structural Glued Laminated Douglas Fir (Coast Region) Timber, 1962 Edition, West Coast Lumberman's Association" and the 1961 Uniform Building Code (UBC). Both documents outline code requirements for the design of glulam timber members.

Both codes required modification to the member stresses due to the duration of load. The load duration modification allowed the allowable unit stresses to be increased by 15% for loads with a two-month duration and 25% for a 7-day duration. It also required the allowable stresses to be decreased by 90% for loads continuously supported for multiple years (aka dead loads).

The 1962 Edition also required the use of a curvature factor and radial tension or compression factor for curved members, which is not applicable to the roof beams.

The American Institute of Timber Construction (AITC) Tech Note 21 "Volume Factor for Structural Glued Laminated Timber" dated April 2023 describes the evolution of the adjustment factor required to be applied to adjust for the size of a bending member. In 1954, a depth factor was published to acknowledge the effect of depth on glulam timber beams. For the gym roof beam geometry, the depth factor would require a reduction to the allowable bending strength of 0.82.

Current Wood Construction Code Requirements

The structural design with wood products, including glulam members, is governed by the National Design Specification (NDS) For Wood Construction, 2018 Edition per the 2022 OSSC.

The 2018 NDS allowable stress design (ASD) requires glulam members to be modified by load duration, wet service, temperature, beam stability, volume, curvature, and stress interaction adjustment factors when evaluating bending members in flexure. When evaluating the glulam members in shear, glulam members are to be modified by load duration, wet service, temperature, and shear reduction adjustment factors.

The geometry of the glulam roof beams lead to a flat use factor and curvature factor of 1.0 and therefore does not impact the member's design capacity. The wet service factor and temperature factor, for the service condition of the roof beams, would also be 1.0 and therefore do not impact the member's design capacity.

The load duration factor has not changed from those required in the 1962 Edition and UBC codes.

The previously defined depth factor, now called the volume factor, has changed to reflect expanded research on the topic. Current code requires an adjustment to the allowable bending strength of 0.67 for the roof beams width, depth, and length between points of zero moments.

The beam stability factor and stress interaction factors are adjustment factors that were not previously required in 1962 and UBC codes. These two factors are not required to be applied simultaneously with the volume factor and the lesser of the three adjustment factors are to be applied. For the glulam roof beams, the volume factor controls therefore these adjustment factors are not applicable.

Professional Opinion

The beams supported the required roof dead, live, and snow loads for a 60-year service life. The original design for the glulam beams placed the beam's stress limit at about 90% of its capacity, which is a common stress limit for these types of building elements.

However, since the original design, significant knowledge has been gained about deep glulam members which has led to changes in wood codes. These code changes led to a significantly reduced factor of safety in the glulam roof beams from the original design. When comparing the original design loads and using the current code requirements (including the reduced design values described in Section D), the beam members would be about 10% overstressed under only dead loads and 46% overstressed under dead plus 20 PSF snow load.

It is our opinion that the reduced factor of safety was a contributing factor in the beam's capacity to support the loads at the time of failure.

F. LOADS

This section evaluates the gym's dead, live, snow, and other loads on the gym roof to evaluate if any load increase from the original construction was a contributing factor in the roof glulam beam failures.

DEAD LOADS

Structural dead loads include both the structure's self-weight dead loads and superimposed dead loads. Superimposed dead loads include non-structural loads such as ceilings and roofing materials.

Self-Weight Dead Loads

The gym's roof structure self-weight dead loads consisted of 3x Doug Fir decking, 4x14 Nominal Doug Fir joists and the long-span tapered glulam beams.

In the fall of 2024, a seismic retrofit of the entire gym building was completed. The seismic retrofit installed a 5/8" OSB panel diaphragm over the existing 3x decking. No other changes were made to the roof's self-weight.

Original Superimposed Dead Loads

The 1965 architectural drawings identify roofing to include a vapor barrier, rigid insulation, and built-up roof. The drawings do not indicate the depth of rigid insulation or built-up roofing therefore assumptions have been made to determine appropriate thickness and weights.

The existing architectural details appear to indicate that the rigid insulation is slightly deeper than a 2x4 perimeter wood member. We have assumed that the insulation thickness could be 1.5 to 2-inches thick.

It is our understanding that built-up roofing consisted of felt and asphalt. Our research indicates that these types of roof weights can vary between 2 to 5 PSF depending on the number of layers used to build-up the roof.

The existing architectural drawings indicate existing ceiling tiles supported by 2x4 lumber at 12-inch o.c. below the 4x14 timber members. We assumed the ceiling tile weight to be 1 PSF.

Final Superimposed Dead Loads

The 2024 seismic retrofit re-roofed the entire gym building roof. The architectural drawings for the seismic retrofit identify the new roofing to include a vapor barrier, 5.2-inches insulation, ½-inch Densdeck coverboard, and single-ply membrane. The weights of these components have been confirmed by the product data sheets submitted as part of the Operations & Maintenance Manual for the project.

Only light fixture updates were made to the underside of the main gym roof. No changes were made to the existing ceilings.

Professional Opinion

The roof self-weight dead loads appears to have increased by 2.1 PSF due to the new OSB sheathing. The roof superimposed dead loads appear to have been reduced from the original construction by between 1.25 PSF and 5 PSF due to the new lightweight roof installed during the seismic retrofit project. The superimposed dead load reduction is presented as a range due to the unknown thickness of the original built-up roofing.

This results in a potential net increase of 0.85 PSF or a reduction of 2.9PSF in total roof dead load from the original loads. If the original built-up roofing was on the light side, the 0.85 PSF does not increase the dead load by more than 5%.

See Appendix D for a load summary of the self-weight dead load, original and final superimposed dead loads at the main gym roof.

It is our opinion that the seismic retrofit change in dead load was not a contributing factor to the beam failures.

ROOF MEP UNITS

The main gym roof supported minimal MEP equipment. A MEP duct ran east-west on the underside of the roof along the main gym perimeter walls.

Small exhaust hoods were located across the roof and are understood to have been in place since the original construction. The 2024 seismic retrofit replaced in-kind a few damaged exhaust hoods.

Cell phone towers used to be located on the gym roof and were removed during the 2024 seismic retrofit. The cell towers were not replaced.

Professional Opinion

The MEP equipment supported by the roof appears to be lightweight and have been part of the building’s original construction and therefore in our opinion was not a contributing factor in the beam failures.

BASKETBALL HOOP

The two beams that initially failed were supporting a basketball hoop and backstop. It is understood that the basketball hoop was installed between 2008 and 2010, however no documentation for the hoop has been provided for review.

The basketball hoop was supported by four connections, two at each beam near mid-span. The hoop connection to the beam was in the bottom 1/3 of the glulam beam based on photo documentation. Although not recommended, in our experience, it is common practice for gym equipment installers to connect basketball hoop components to the lower half of glulam members.

The basketball hoop at the east end of the gym was also supported in a similar way. We are not aware of any early signs of failure or cracks in the two eastern beams supporting the other hoop.

Field weighing of the basketball hoop identified a self-weight of about 1,200-lbs. without the glass backboard. It is assumed the glass backboard is ½-inch thick and weighed an additional 160-lbs.

The current National Design Specification for Wood Construction does not allow heavy or medium concentrated loads to be suspended below the neutral axis of a structural glulam beam without reinforcement to resist tension stresses perpendicular to grain.

Professional Opinion

Our office practice is to either require these types of connections to be located above the beam's neutral axis or be reinforced to meet the code requirements.

It is our opinion that the basketball hoop connection could have caused local damage to the glulam beam's lower laminations. If damage was caused, the hoop connection and hoop load could have been a contributing factor in the beam's failure.

Since the eastern two beams did not show the same initial signs of failure and we do not have any information to confirm lower lamination damage, it is our opinion that the hoop was not a main contributing factor in the beam's failure.

LIVE LOADS

Structural live loads are intended to represent the maximum loads expected by the intended use or occupancy due to human occupancy, furniture or other temporary factors. They are defined by the presiding building codes.

The original structural drawings indicate a roof live load of 20 psf. Current code in Oregon, the 2022 Oregon Structural Specialty Code (OSSC), also recommends a roof live load of 20 psf.

Professional Opinion

Live loads were not present at the time of glulam beam failure therefore it is not applicable when reviewing the cause of failure. The original design loads are important to know since they provide insight into the glulam beam's original expected capacity.

SNOW LOADS

Snow loads were not introduced into the structural codes in Oregon until 1971. Since then, code requirements have evolved with the help of the Structural Engineers of Oregon (SEAO), US Soil Conservation Service, Oregon State University, and the State Engineer of Oregon.

Current Code Snow Load

Current code snow load requirements are defined by national codes such as the International Building Code and ASCE 7-16 Minimum Design Loads for Buildings and Other Structures. The Oregon Structural Specialty Code (OSSC) gives state specific requirements for snow loads including the requirement to use the ground snow load map published by SEAO.

For this structure, the current code in Oregon would require a roof snow load of 27 PSF with a density of 14.52-lb./ft.^3. This considers the gym's risk category of III, roof exposure, thermal condition, and slope.

Event Snow Load

The actual snow depth, density, and weight of snow on the gym roof before or during the collapse cannot be known with certainty.

Information from National Operational Hydrologic Remote Sensing Center (NOHRSC) website, National Oceanic and Atmospheric Administration (NOAA) website, in addition to Medford School District staff's firsthand account of the event were used to inform the snow scenarios.

NOAA identifies a combined total new snow depth of about 9.1-inches and NOHRSC identifies an estimated 8 to 12-inches on the ground between February 3 and the initial beam failures on February 7. NOAA also recorded an additional 1.89-inches of rain over the same time period.

The snow on the roof was described to be 6-inches deep and as very saturated and wet. Wet and saturated snow can weigh between 25-lb/ft^3 to 52-lb/ft^3 depending on the level of saturation.

KPFF evaluated several snow load scenarios that resulted in load ranging from 10 PSF to 27 PSF. See Appendix E for the snow load determination.

Snowfall Records

Annual snow fall records from 1965 through February 14th, 2025 and climatology data were obtained from NOAA so that the history of precipitation data near the school could be evaluated.

The records show that the building has likely experienced snow events similar to the event in February 2025. It is possible that past snow events may have led to initial damage in the glulam beams thereby compromising their capacity.

Roof Insulation

We understand the seismic retrofit project increased the roof's R-value to provide better thermal performance. A higher R-value provides increased energy efficiency. This improved thermal performance can lead to more snow accumulation on roofs since heat transfer through the building roofing will not influence snow melting.

Professional Opinion

The structure was not originally designed with snow loads however current codes do not require snow and roof live loads to be simultaneously considered. Therefore the 20 PSF live load allowance included in the original design would have provided a snow load allowance of 20 PSF.

Since the initial beam failures occurred under snow loads, it is our opinion that the snow load on the gym roof was a contributing factor.

PONDING INSTABILITY

Current code require roofs to be designed to preclude ponding instability. Ponding can occur where adequate slope to drain does not exist, or where drains are blocked. Ponding allows snow meltwater and rain to pond in low areas leading to increased deflections in these areas and eventually a failure due to the localized overload.

Current code recommends roofs to be sloped with a minimum of ¼" per foot to preclude ponding.

The existing structural drawings utilized tapered glulam beams to clear span the main gym. Although the gym is a low-slope roof (slope less than 15-deg), the tapered glulam geometry was set to provide for a ¼" per foot meeting the code recommended slope to preclude ponding. For this roof geometry, it provided a rise of 14-inch from end of beam to mid-span.

The 1965 structural drawings indicate that the tapered glulam beams were cambered 6-inches upward at mid-span. This initial camber was specified to counteract the roof's total dead load (self-weight and superimposed loads) to ensure the roof maintained the minimum roof specified slope.

The deflections of the tapered glulam members under different snow load scenarios were evaluated and all produced a snow load induced deflection of 6-inches or less.

Discussions with the Medford School District also indicate that after the initial beam failures, the roof drains were inspected and confirmed to not be blocked.

Professional Opinion

Low-slope roofs (slopes less than 15-deg) are common and appropriate when detailed appropriately to provide the minimum code required roof slopes. Our review of the existing structural drawings indicate that the design provided the appropriate beam camber and sloped structural members to meet the code requirements for a low-slope roof.

The deflections due to snow at the tapered glulam beams, before the beam failures, would not have created a ponding instability. Therefore, it is our opinion that ponding instability was not a contributing factor to the initial beam failures.

Once the beam failures were initiated and deflection occurred, ponding instability contributed to the progressive collapse of the remaining main gym roof beams.

G. STRUCTURAL ANALYSIS

A structural engineering design review was performed for the roof beams based on all the information obtained.

LOADS

The following is a summary of the loads used in the design review of the gym roof beams.

Original Loads	
Total Dead Load	16.0 PSF (Low-Range for Total Dead Load) 19.8 PSF (High-Range for Total Dead Load)
Roof Live Load	20 PSF
Roof Snow Loads	Not Applicable

Loads at Time of Failure	
Total Dead Load	16.9 PSF (Seismic Retrofit Total Dead Load)
Roof Live Load	20 PSF
Potential Event Snow Loads (6-inches Wet Snow)	12.5 PSF (Low Wet Snow Density) 25.9 PSF (High Wet Snow Density)

DESIGN AND CAPACITY BASED ON CURRENT CODE

The following identify the flexural demand-to-capacity or how overstressed the glulam roof beams were based on specific loads and different code requirements.

Considering original design loads and original code requirements:

- Under full design load (dead plus roof live load), the flexural design-to-capacity ratio was between 0.8 and 0.9 or 80-90% of its stress limit. The higher stress was with the high-range roof dead load.

Considering original loads, 25% reduction due to the tension laminations and code changes:

- Under permanent dead loads, the beams were overstressed by approximately 10%.

Considering loads at time of failure, 25% reduction due to the tension laminations and code changes:

- Under dead load and potential snow event loads, the beams would have been overstressed by between 5 to 45% based on a load duration of 7 days depending on snow density.

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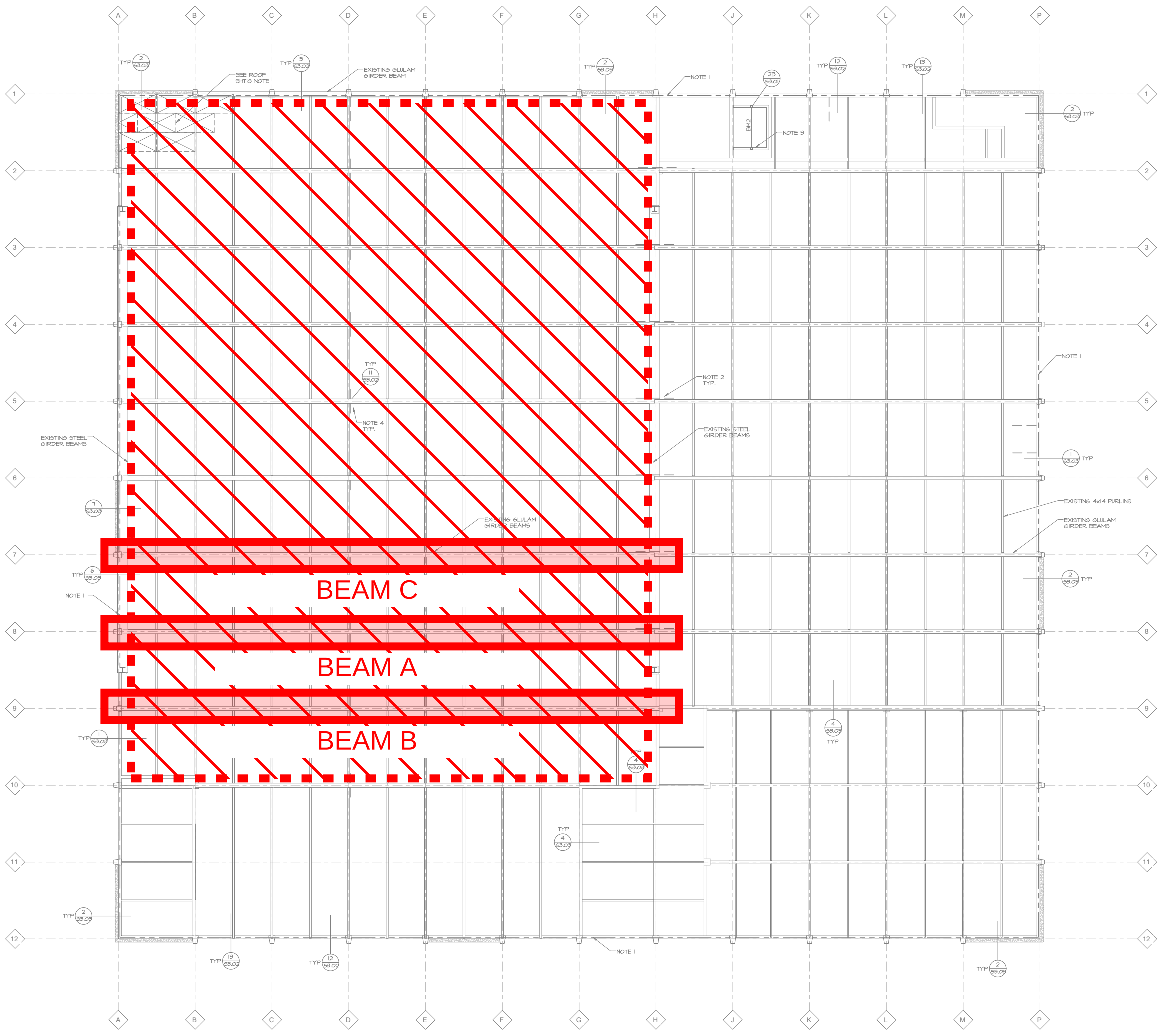
Portland, Oregon

Project North Medford Gym Collapse	By KMR	Sheet No. A.1
Location Medford, OR	Date 4/23/25	
Client Medford School District	Revised	Job No.
Appendix A - Roof Plan	Date	

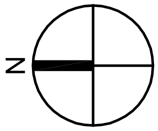


LEGEND

▨ INDICATES COLLAPSED ROOF AREA

🟥 ROOF BEAM THAT EXHIBITED INITIAL SIGNS OF FAILURE

A ROOF PLAN



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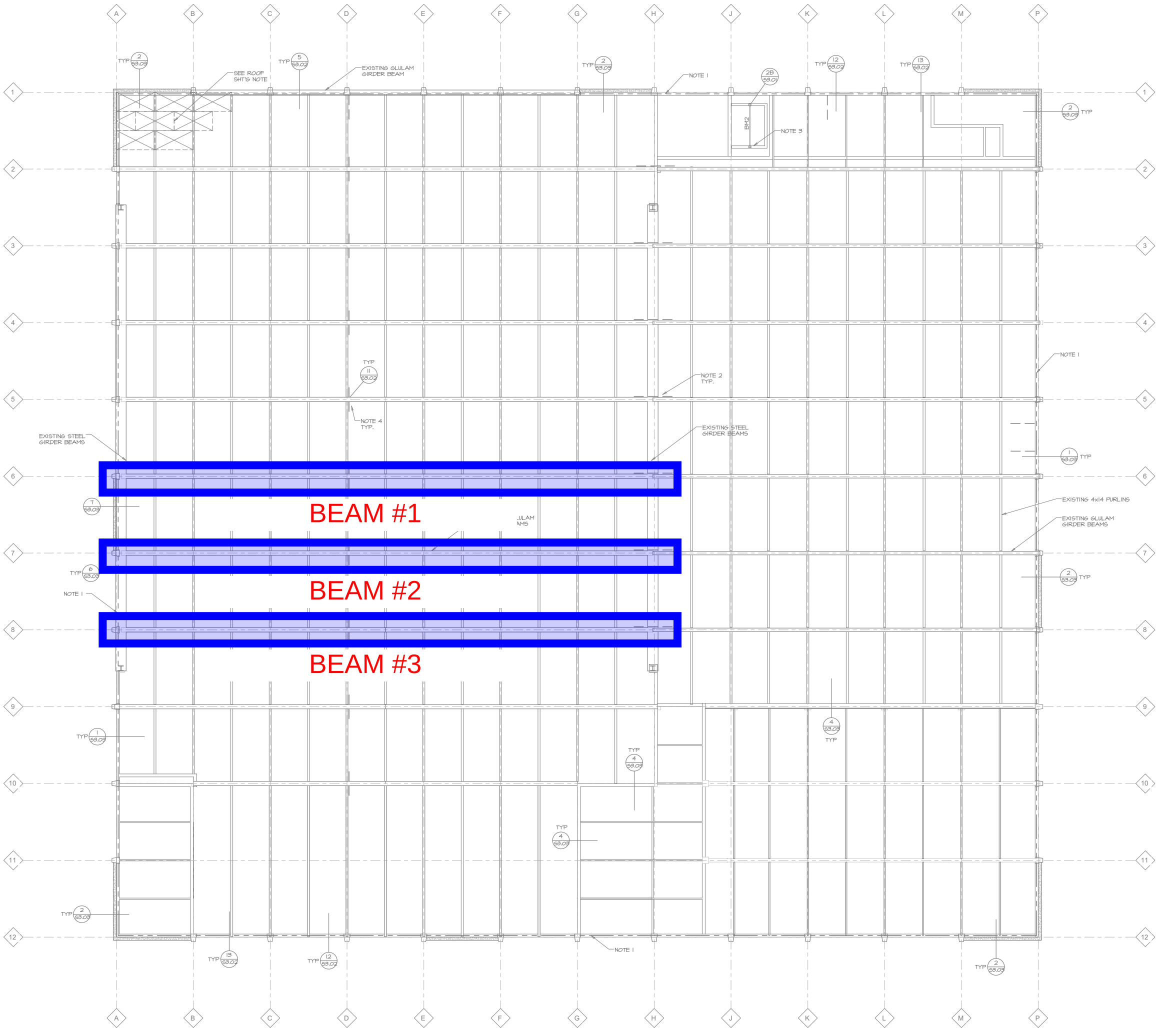
Project North Medford Gym Collapse	By KMR	Sheet No. B.1
Location Medford, OR	Date 4/23/25	
Client Medford School District	Revised	Job No.
Appendix B - Beam Locations	Date	



LEGEND

🟦 ROOF BEAM MADE AVAILABLE FOR ONSITE REVIEW ON 3/21/25 AND 3/25/25.

A ROOF PLAN

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Portland, Oregon

Project North Medford Gym Collapse	By KMR	Sheet No. C.1
Location Medford, OR	Date 4/23/25	
Client Medford School District	Revised	Job No.
Appendix C - Resistograph Readings	Date	

APPENDIX C:
RESISTOGRAPH READINGS

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Portland, Oregon

Project	North Medford Gym Collapse	By	KMR	Sheet No. C.2
Location	Medford, OR	Date	4/23/25	
Client	Medford School District	Revised		Job No.
Appendix C - Resistograph Readings		Date		

Resistograph General Information

A resistograph measures the torque and force necessary to drill a 1/8” diameter drilling needle into a piece of wood. Any drop in feed resistance or torque can be correlated to a void in the member because of decay. Resistograph readings were taken in three locations for each glulam, one at each end of the beams as well as one reading closest to the center as possible. All readings were taken from the top of each beam and can be found in Appendix C. All resistograph readings indicated sound wood with any drops in drilling resistance corresponding to cracks and mechanical damage sustained by the glulams.

Additional Comments regarding Resistograph Data Sheets

Cardinal directions indicated are in reference to how the beams were oriented originally in the structure.

Gridlines referenced are derived from the seismic retrofit drawings dated 3/22/24.

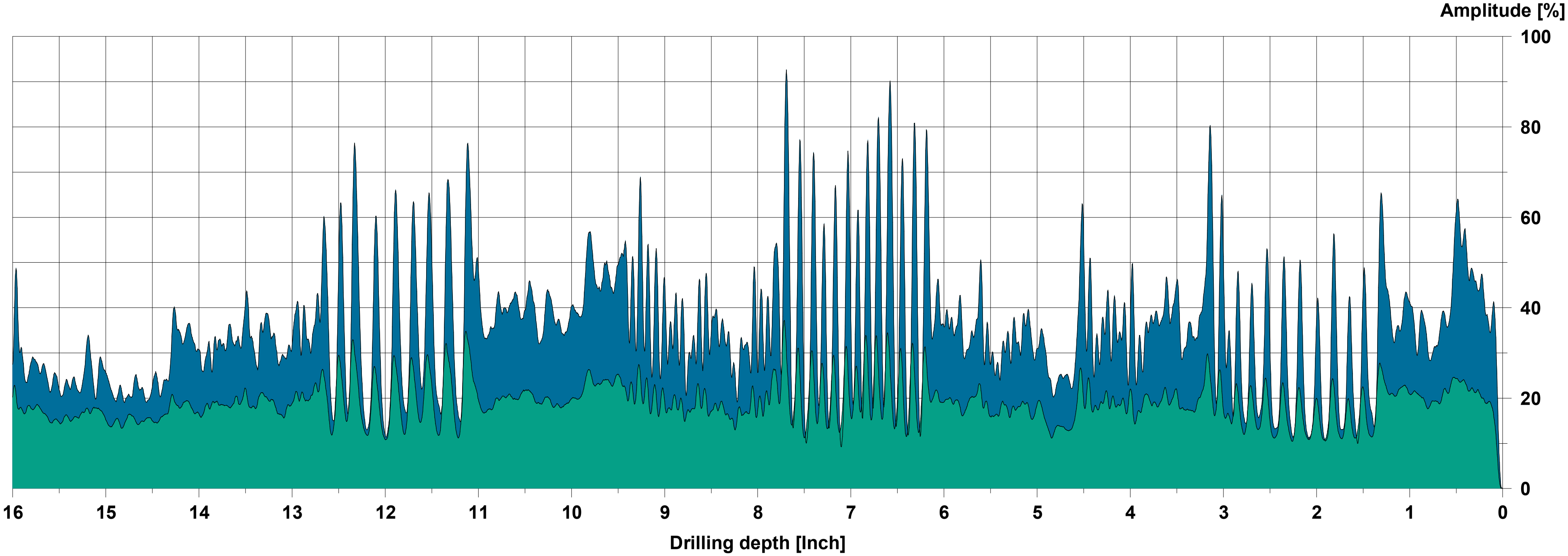
Note: Cardinal directions indicated are in reference to how the beams were oriented originally in the structure.

Measuring / object data

Measurement no.	259	Speed	3500 r/min	Diameter:	
ID number	MEDBEAM	Needle state:	---	Level	
Drilling depth	19,75 in	Tilt	-4°	Direction:	
Date	21.03.2025	Offset	111 / 291	Species	
Time	14:20:51	Avg. curve	off / off	Location	
Feed	50 in/min			Name	

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

1NORTH

2' from the north end of Beam #1

Measurement259.rgp

Measuring / object data

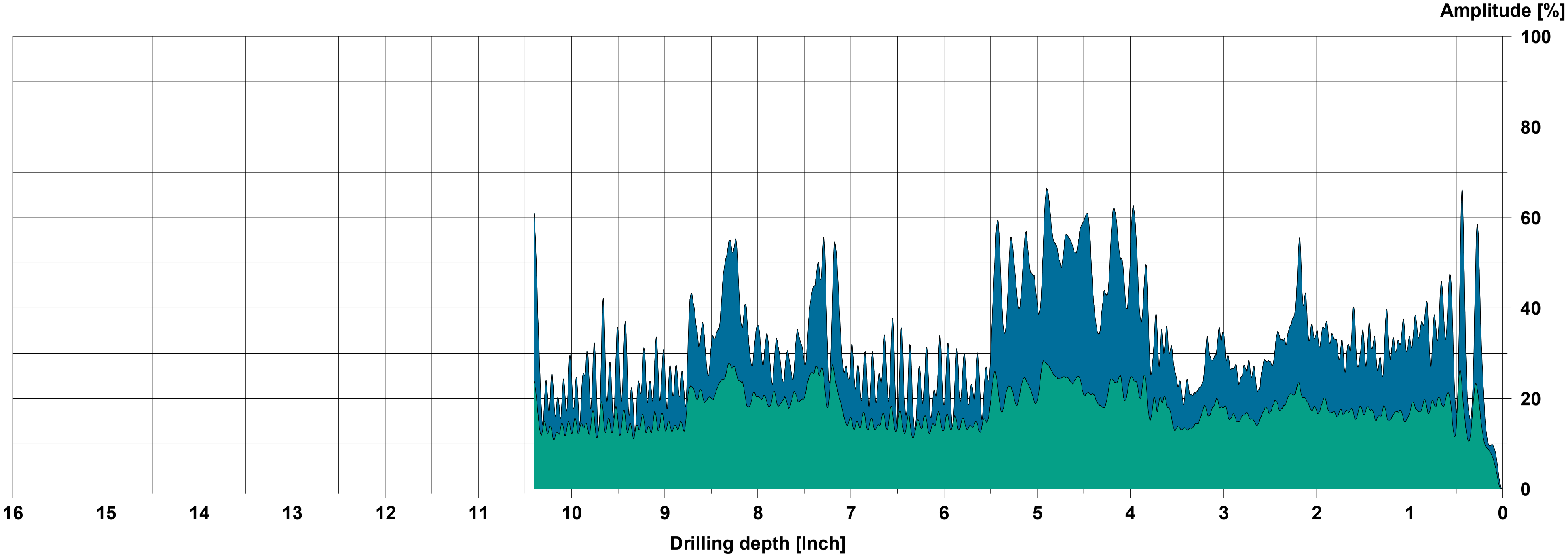
Measurement no.: 260
ID number : MEDBEAM
Drilling depth : 10,40 in
Date : 21.03.2025
Time : 14:22:16
Feed : 50 in/min

Speed : 3500 r/min
Needle state: ---
Tilt : -13°
Offset : 94 / 286
Avg. curve : off / off

Diameter:
Level :
Direction:
Species :
Location:
Name :

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

1MID

Measurement prematurely stopped, full measurement taken 1" away can be found on #261

Measurement260.rgp

Measuring / object data

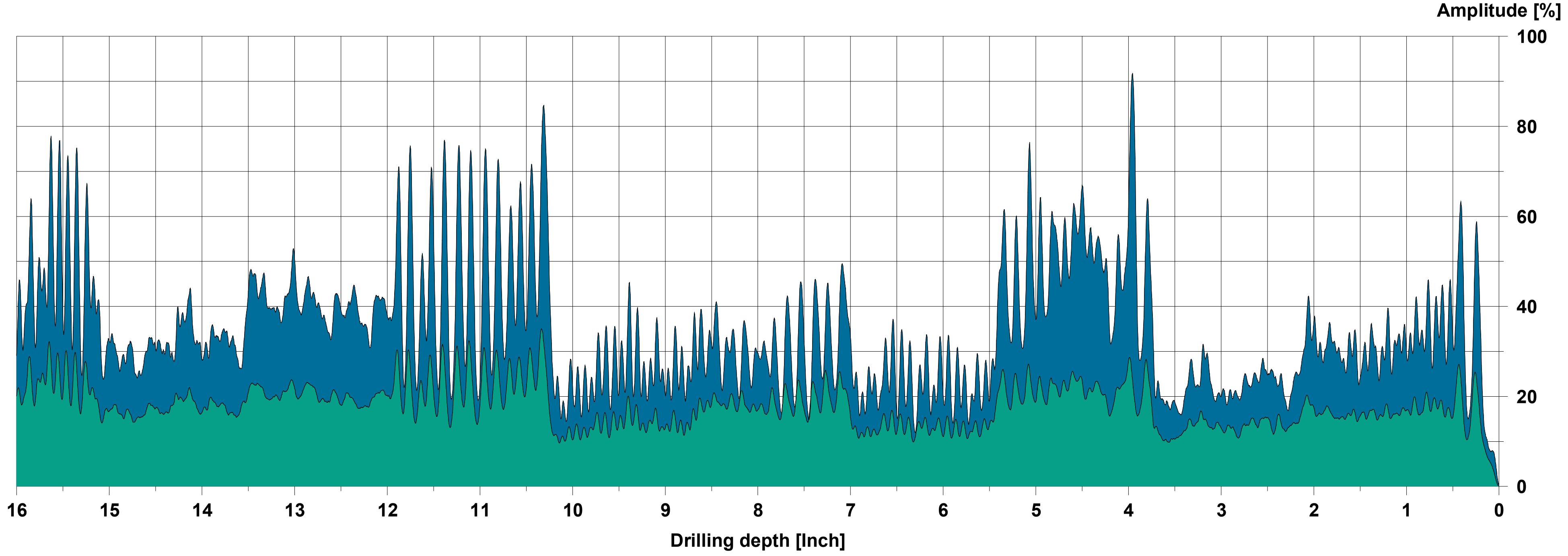
Measurement no.: 261
ID number : MEDBEAM
Drilling depth : 19,75 in
Date : 21.03.2025
Time : 14:22:41
Feed : 50 in/min

Speed : 3500 r/min
Needle state: ---
Tilt : -14°
Offset : 92 / 287
Avg. curve : off / off

Diameter:
Level :
Direction:
Species :
Location :
Name :

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

1MID
Center of Beam #1

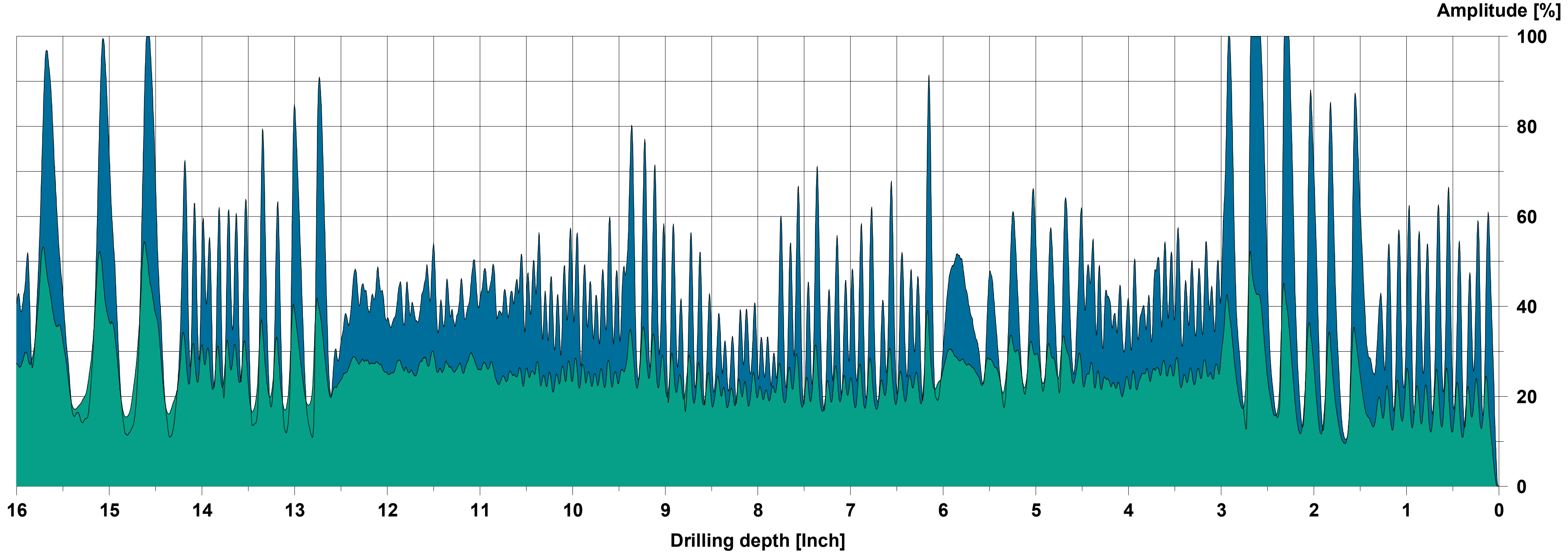
Measurement261.rgp

Measuring / object data

Measurement no.	: 262	**Speed**	: 3500 r/min	**Diameter**	:
ID number	: MEDBEAM	**Needle state**	: ---	**Level**	:
Drilling depth	: 19,75 in	**Tilt**	: -5°	**Direction**	:
Date	: 21.03.2025	**Offset**	: 92 / 287	**Species**	:
Time	: 14:24:25	**Avg. curve**	: off / off	**Location**	:
Feed	: 50 in/min			**Name**	:

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

1SOUTH

2' from the South end of Beam #1

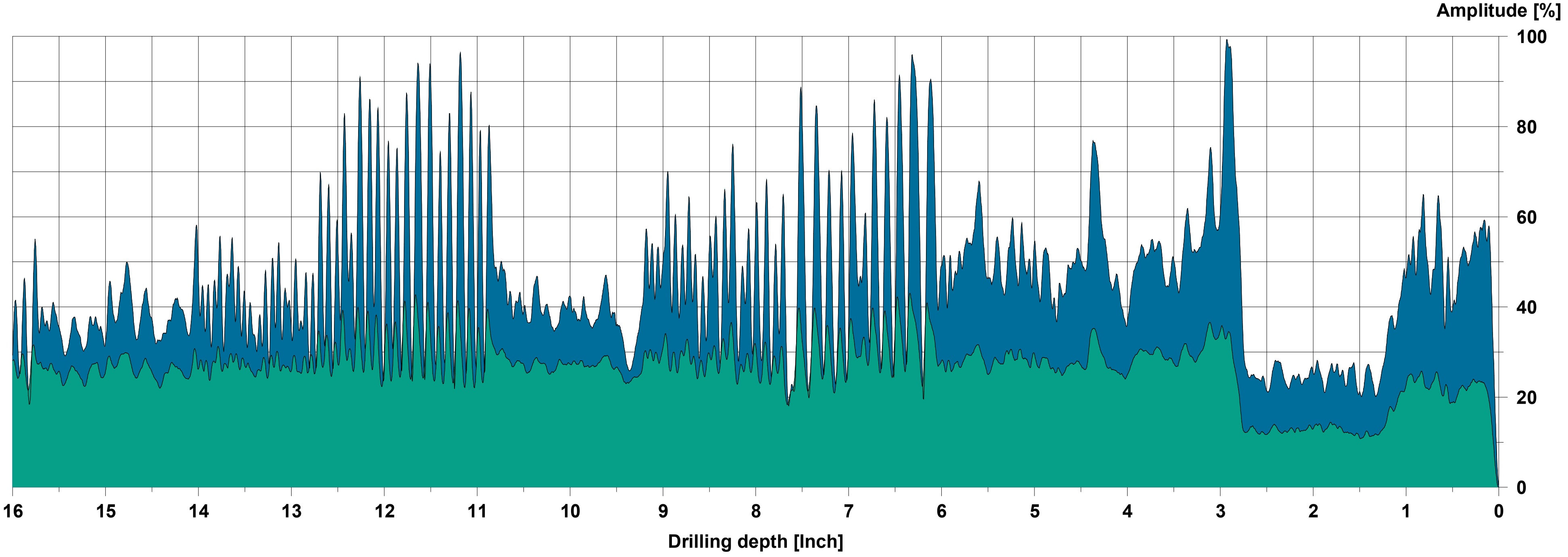
Measurement262.rgp

Measuring / object data

Measurement no.	: 263	Speed	: 3500 r/min	Diameter	:	
ID number	: MEDBEAM	Needle state	: ---	Level	:	
Drilling depth	: 19,74 in	Tilt	: -7°	Direction	:	
Date	: 21.03.2025	Offset	: 92 / 281	Species	:	
Time	: 14:25:40	Avg. curve	: off / off	Location	:	
Feed	: 50 in/min			Name	:	

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

2SOUTH

2' from the South end of Beam #2

Measurement263.rgp

Measuring / object data

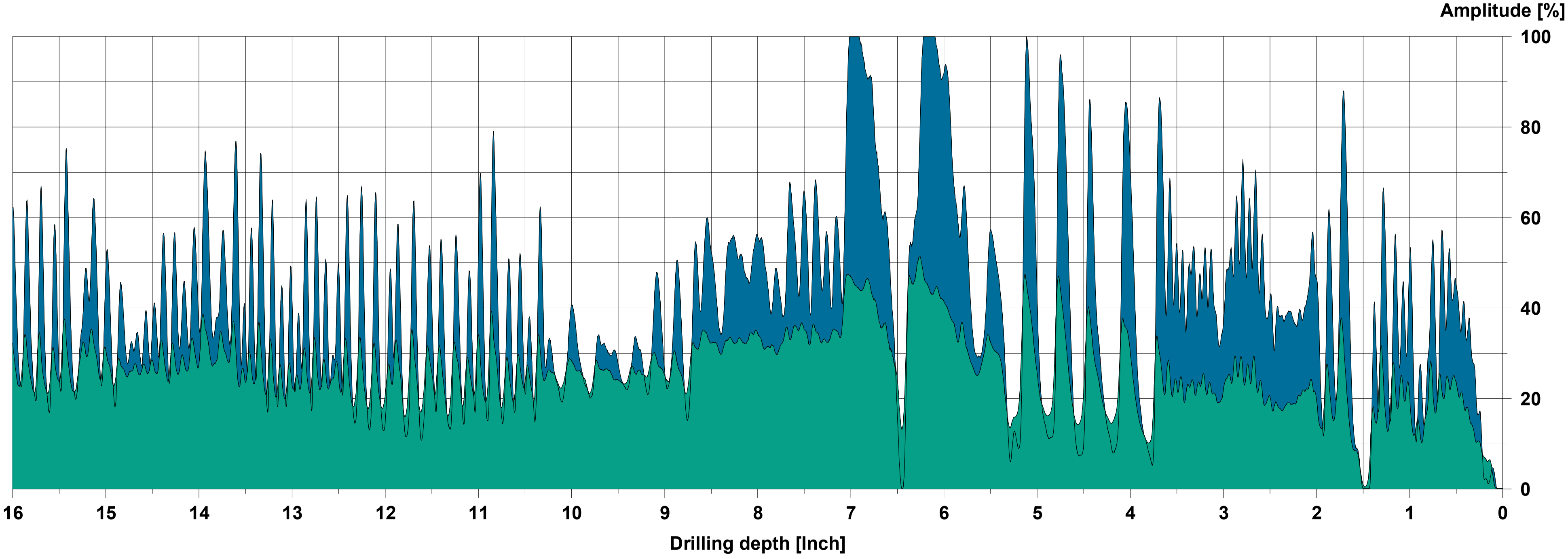
Measurement no.: 264
ID number : MEDBEAM
Drilling depth : 19,75 in
Date : 21.03.2025
Time : 14:28:16
Feed : 50 in/min

Speed : 3500 r/min
Needle state: ---
Tilt : -29°
Offset : 86 / 279
Avg. curve : off / off

Diameter:
Level :
Direction:
Species :
Location :
Name :

WoodInspector

Off



Assessment

Crack encountered at 1.5" and 6.5".

Comment

2MID

Center of Beam #2

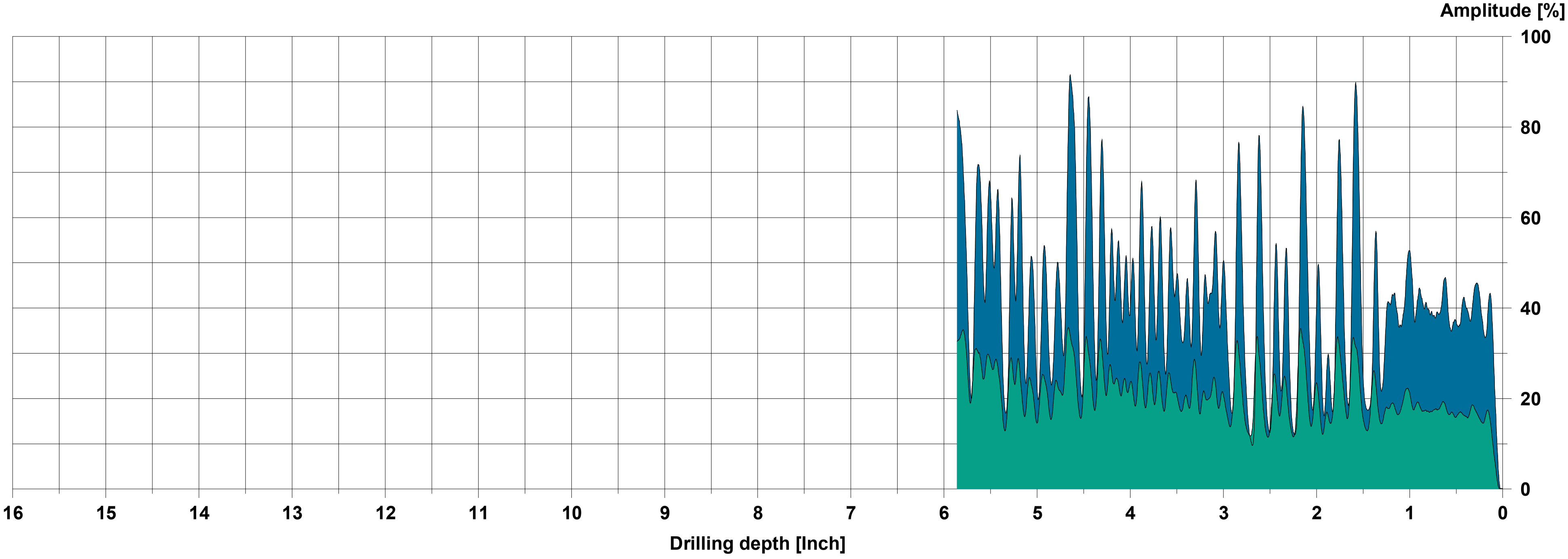
Measurement264.rgp

Measuring / object data

Measurement no.:	265	Speed :	3500 r/min	Diameter:	
ID number :	MEDBEAM	Needle state:	---	Level :	
Drilling depth :	5,86 in	Tilt :	-18°	Direction:	
Date :	21.03.2025	Offset :	91 / 280	Species :	
Time :	14:30:21	Avg. curve :	off / off	Location :	
Feed :	50 in/min			Name :	

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

2NORTH

Measurement prematurely stopped, full measurement taken 1" away can be found on #267

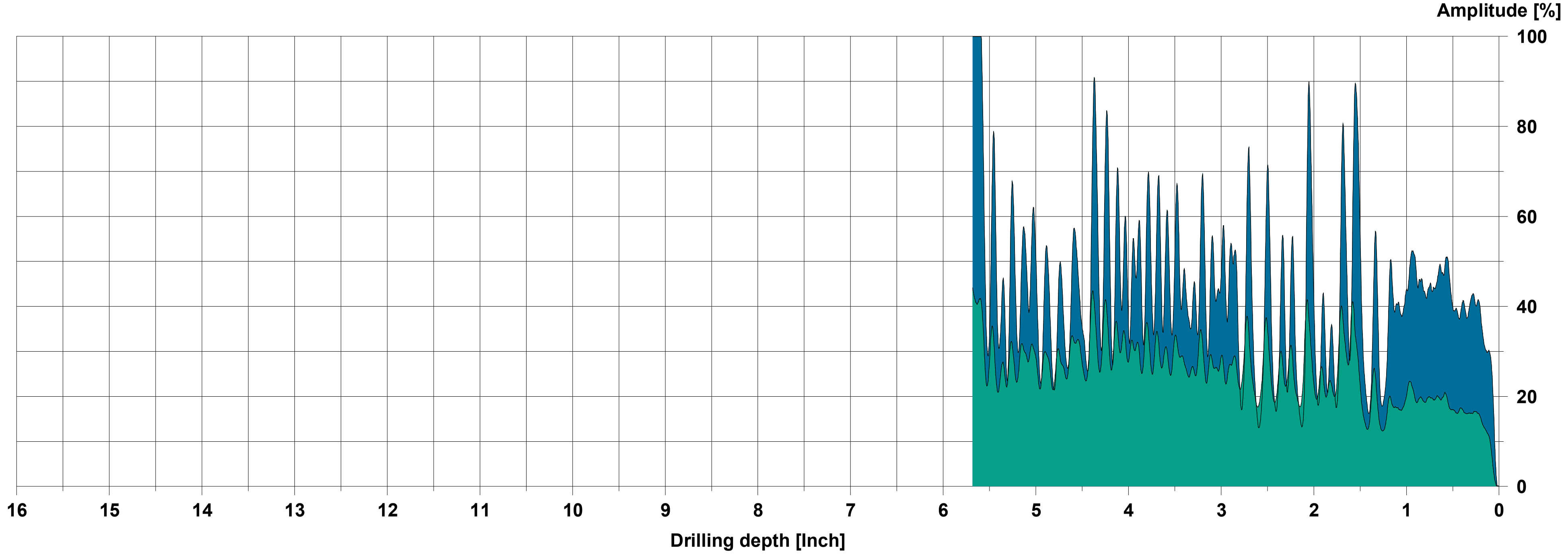
Measurement265.rgp

Measuring / object data

Measurement no.	: 266	**Speed**	: 3500 r/min	**Diameter**	:
ID number	: MEDBEAM	**Needle state**	: ---	**Level**	:
Drilling depth	: 5,68 in	**Tilt**	: -16°	**Direction**	:
Date	: 21.03.2025	**Offset**	: 88 / 284	**Species**	:
Time	: 14:30:41	**Avg. curve**	: off / off	**Location**	:
Feed	: 50 in/min			**Name**	:

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

2NORTH
Measurement prematurely stopped, full measurement taken 1" away can be found on #267

Measurement266.rgp

Measuring / object data

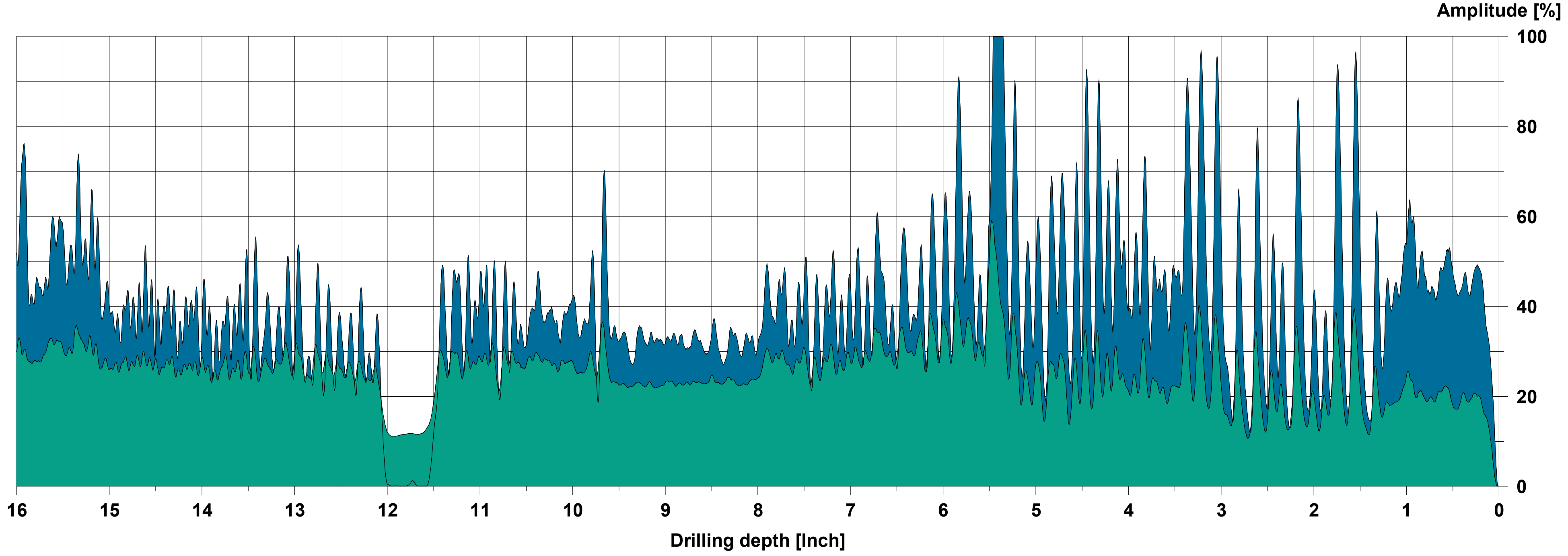
Measurement no.: 267
ID number : MEDBEAM
Drilling depth : 16,74 in
Date : 21.03.2025
Time : 14:31:24
Feed : 50 in/min

Speed : 3500 r/min
Needle state: ---
Tilt : -15°
Offset : 87 / 292
Avg. curve : off / off

Diameter:
Level :
Direction:
Species :
Location:
Name :

WoodInspector

Off



Assessment

Low reading at 12" consistent with large crack due to mechanical damage of the member

Comment

2NORTH

2' from the North end of Beam #2

Measurement267.rgp

Measuring / object data

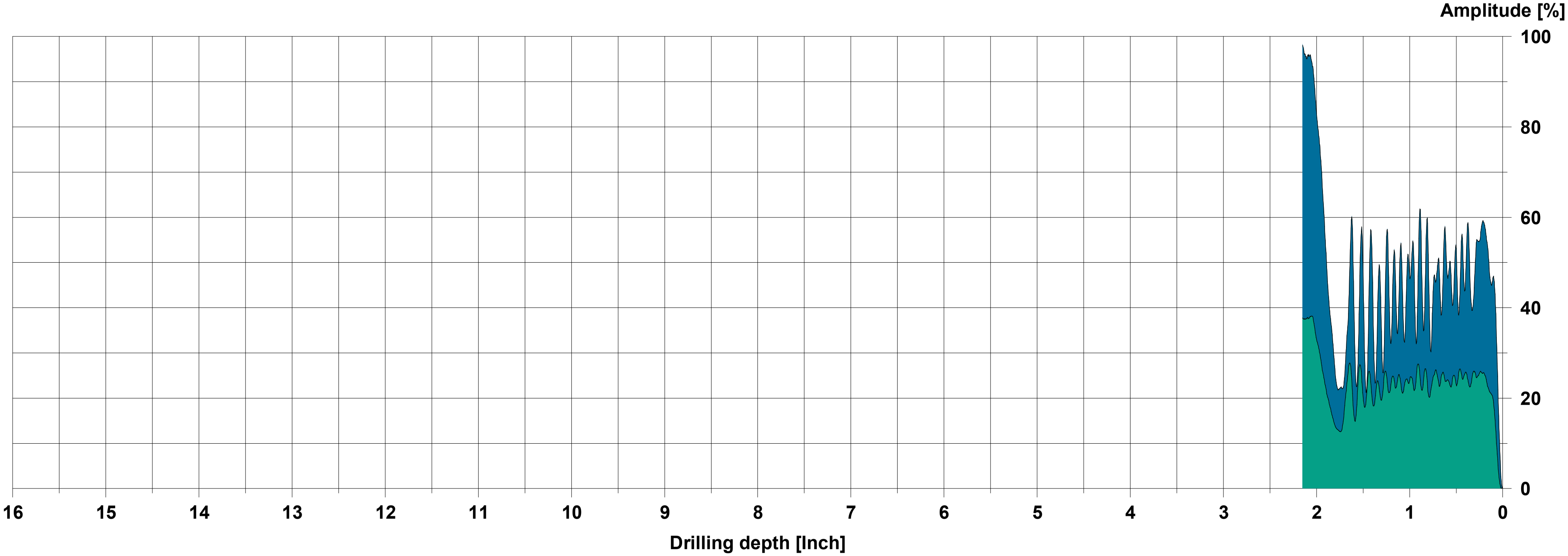
Measurement no.: 268
ID number : MEDBEAM
Drilling depth : 2,15 in
Date : 21.03.2025
Time : 14:33:50
Feed : 50 in/min

Speed : 3500 r/min
Needle state: ---
Tilt : -5°
Offset : 94 / 283
Avg. curve : off / off

Diameter:
Level :
Direction:
Species :
Location :
Name :

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

3NORTH

Measurement prematurely stopped, full measurement taken 1" away can be found on #269

Measurement268.rgp

Measuring / object data

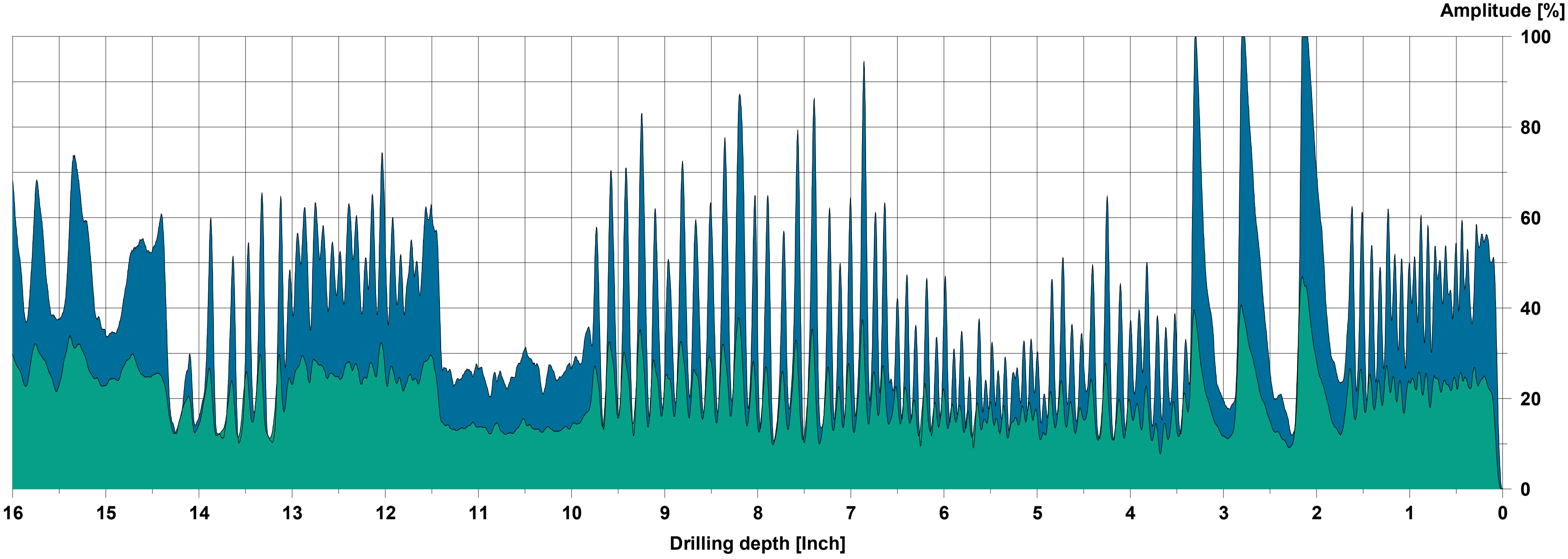
Measurement no.: 269
ID number : MEDBEAM
Drilling depth : 19,75 in
Date : 21.03.2025
Time : 14:33:58
Feed : 50 in/min

Speed : 3500 r/min
Needle state: ---
Tilt : -4°
Offset : 87 / 291
Avg. curve : off / off

Diameter:
Level :
Direction:
Species :
Location:
Name :

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

3NORTH

2' from the North end of Beam #3

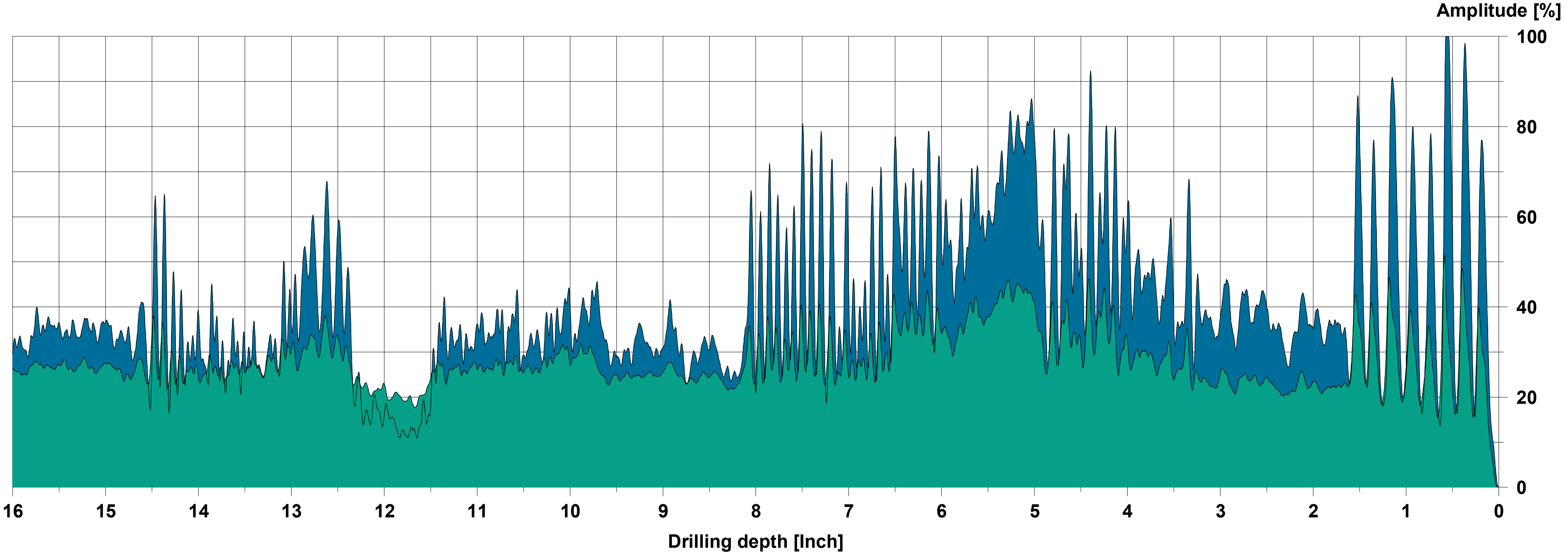
Measurement269.rgp

Measuring / object data

Measurement no.	: 270	Speed	: 3500 r/min	Diameter	:	
ID number	: MEDBEAM	Needle state	: ---	Level	:	
Drilling depth	: 19,75 in	Tilt	: -15°	Direction	:	
Date	: 21.03.2025	Offset	: 90 / 279	Species	:	
Time	: 14:35:27	Avg. curve	: off / off	Location	:	
Feed	: 50 in/min			Name	:	

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

3MID

Center of Beam #3

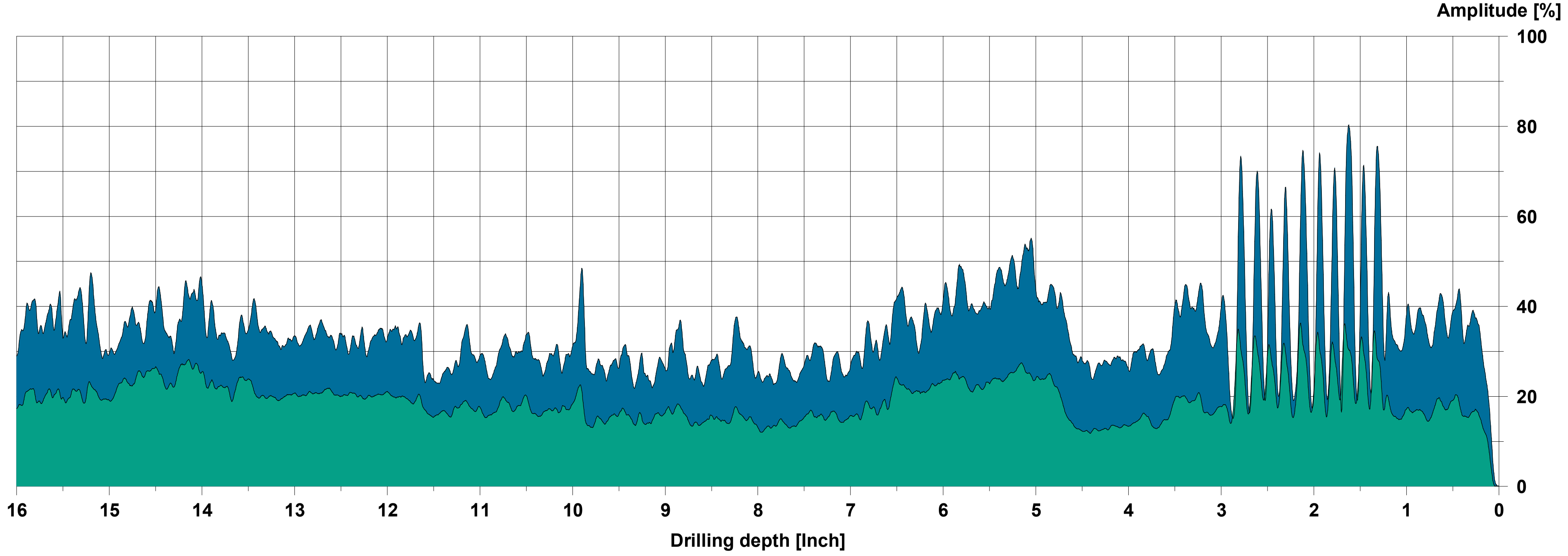
Measurement270.rgp

Measuring / object data

Measurement no.: 271	Speed	: 3500 r/min	Diameter:	
ID number : MEDBEAM	Needle state:	---	Level :	
Drilling depth : 19,71 in	Tilt	: -18°	Direction:	
Date : 21.03.2025	Offset	: 86 / 298	Species :	
Time : 14:36:53	Avg. curve	: off / off	Location :	
Feed : 50 in/min			Name :	

WoodInspector

Off



Assessment

Sound wood throughout measurement

Comment

3 South
2' from the South end
of Beam #3

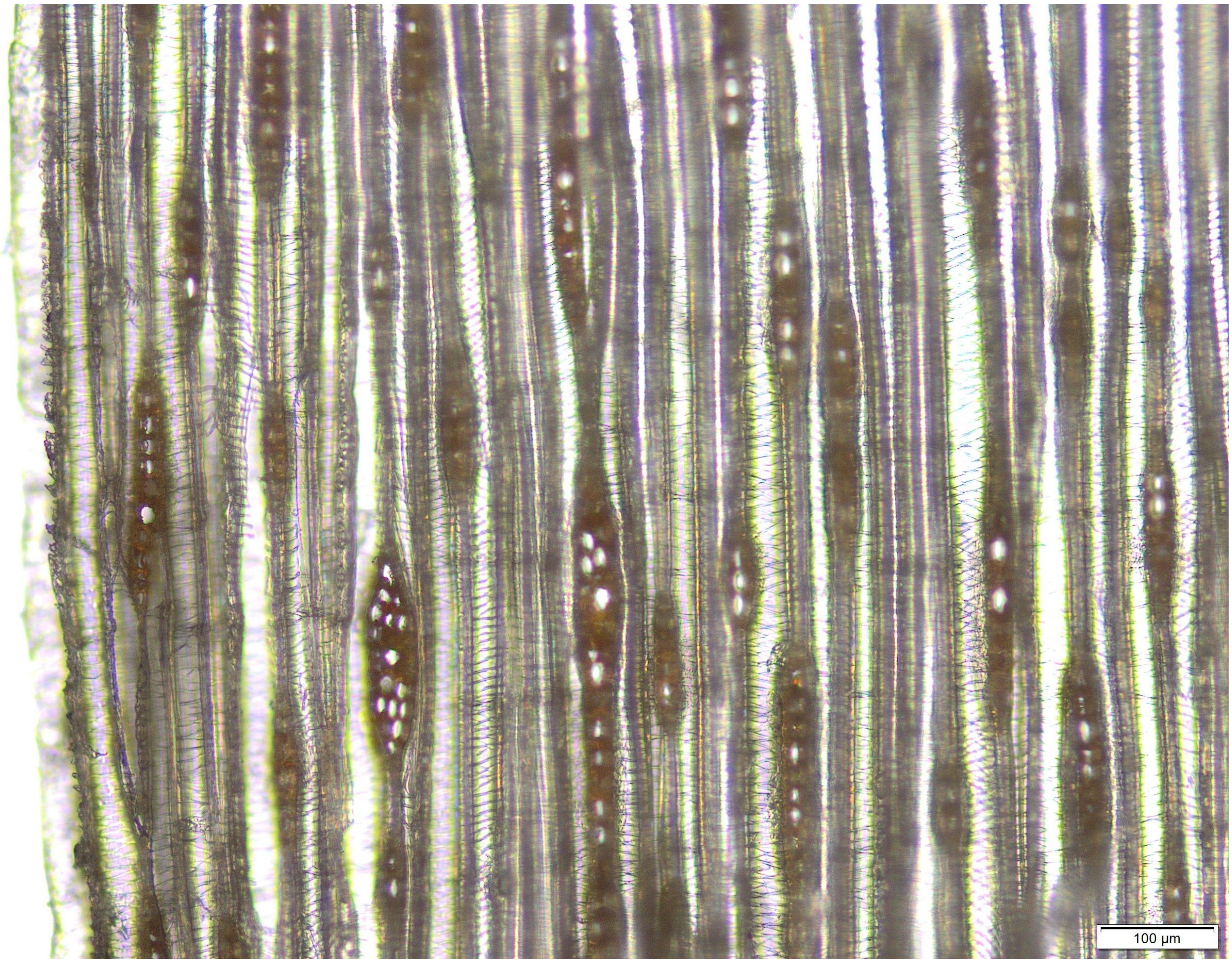
Measurement271.rgp

APPENDIX D:
WOOD IDENTIFICATION

kpff
Portland, Oregon

Project North Medford Gym Collapse	By KMR	Sheet No. D.2
Location Medford, OR	Date 4/23/25	
Client Medford School District	Revised	Job No.
Appendix D - Wood Identification	Date	

Tangential view of sample recovered from Beam #2. Ubiquitous presence of spiral thickenings in longitudinal tracheids in conjunction with fusiform rays cells positively identify Douglas fir (*pseudotsuga menziesii*).



kpff Portland, Oregon	Project	North Medford Gym Collapse	By	KMR	Sheet No. E.1
	Location	Medford, OR	Date	4/23/25	
	Client	Medford School District	Revised		Job No.
		Appendix E - Roof Loads	Date		

APPENDIX E: ROOF LOADS

Project: Medford Gym Collapse	By: KMR	Sheet No.	
Location: Medford, OR	Date: 04/23/25		
Client: Medford School District	Revised:	Job No.	
Subject: Roof - Original Gravity Load Assumptions	Date:	22400083	

Load Assumptions

LOAD TYPE: Original Roof

Existing CDL	Weight	Notes
3x D. Fir Decking	6.625 psf	*2.5" Lumber, D. Fir Decking (Density = 31.8lb/ft^3, AISC Table 17-12)*
4x14 Nominal D.Fir Joist @ 8'o.c.	1.280 psf	*3.5"x13.25" timber, D. Fir (Density = 31.8lb/ft^3, AISC Table 17-12)*
Σ =	**7.905 psf**	

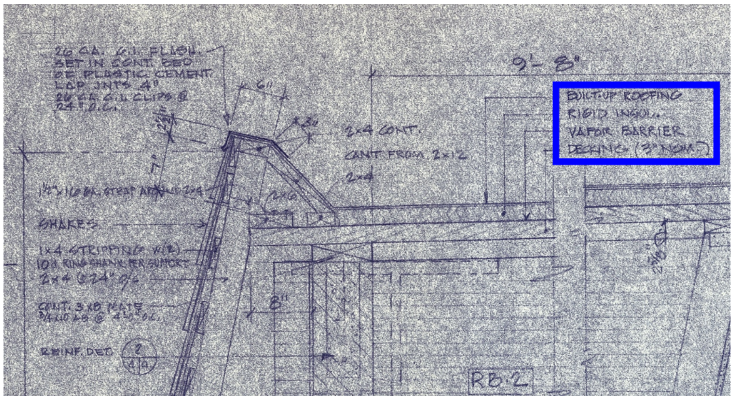
**Does not include GL roof beam self-weight*

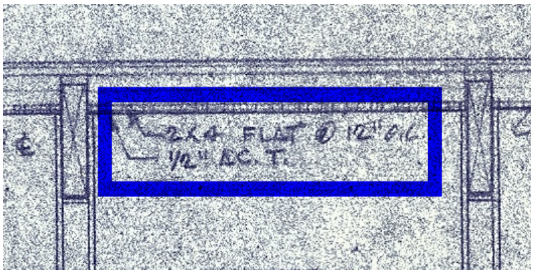
	Weight		
Existing Roofing SDL	**Low Range**	**High Range**	**Notes**
Vapor Barrier	0.700 psf	0.700 psf	*Assumed similar weight to singly-ply waterproofing membrane sheet (ASCE 7-16, Table C3.1-1a)*
1.5" to 2" Rigid Insulation	2.250 psf	3.000 psf	*Assumed 0.75 PSF per 1/2" (ASCE 7-16, Table C3.1-1a)*
Built-up Roofing	2.000 psf	5.000 psf	*Assumed felt and asphault (weight range based on information from Nations Roof)*
Σ =	**4.950 psf**	**8.700 psf**	

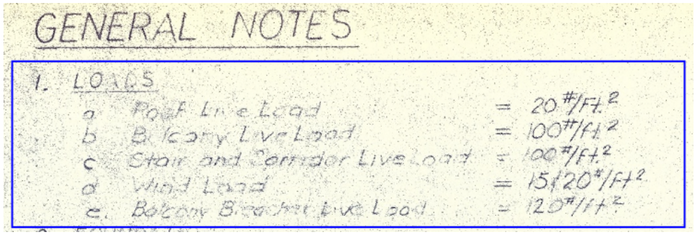
Existing Ceiling SDL	Weight	Notes
2x4 Flat @ 12" o.c.	1.159 psf	*1.5"x3.5" timber, D. Fir (Density = 31.8lb/ft^3, AISC Table 17-12)*
1/2" Adhered Ceiling Tiles	1.000 psf	*Accoustical fiberboard (ASCE 7-16, Table C3.1-1a)*
Lighting & MEP	1.000 psf	*Minimal lighting and MEP in the main gym space.*
Σ =	**3.159 psf**	

	Weight	
Total CDL + SDL	**Low Range**	**High Range**
CDL =	7.905 psf	7.905 psf
SDL =	8.109 psf	11.859 psf
Σ =	**16.015 psf**	**19.765 psf**

Live/Snow Loads	Weight	Notes
Roof Live Load =	20 psf	*Per original structural drawings*






GENERAL NOTES

1. LOADS
   - a Roof Live Load = 20#/Ft.²
   - b Balcony Live Load = 100#/Ft.²
   - c Stair and Corridor Live Load = 100#/Ft.²
   - d Wind Load = 15/20#/Ft²
   - e. Balcony Bleacher Live Load = 120#/Ft.²

kpff	Project:	Medford Gym Collapse	By:	KMR	Sheet No.
	Location:	Medford, OR	Date:	04/23/25	
	Client:	Medford School District	Revised:		Job No.
	Subject:	Roof - New Gravity Load Assumptions	Date:		22400083

Load Assumptions

LOAD TYPE: New Roof (Over existing 3x Decking)

Existing CDL	**Weight**	**Notes:** ***No change to existing roof CDL.***
3x D. Fir Decking	6.625 psf	*2.5" Lumber, D. Fir Decking (Density = 31.8lb/ft^3, AISC Table 17-12)*
4x14 Nominal D.Fir Joist @ 8'o.c.	1.280 psf	*3.5"x13.25" timber, D. Fir (Density = 31.8lb/ft^3, AISC Table 17-12)*
Σ =	**7.905 psf**	
	**Does not include GL roof beam self-weight*	

Existing Ceiling SDL	**Weight**	**Notes:** ***No change to existing roof ceiling SDL.***
2x4 Flat @ 12" o.c.	1.159 psf	*1.5"x3.5" timber, D. Fir (Density = 31.8lb/ft^3, AISC Table 17-12)*
1/2" Adhered Ceiling Tiles	1.000 psf	*Accoustical fiberboard (ASCE 7-16, Table C3.1-1a)*
Lighting & MEP	1.000 psf	*Minimal lighting and MEP in the main gym space.*
Σ =	**3.159 psf**	

Addn'l CDL + SDL*	**Roof**	**Notes**
5/8" OSB (CDL)	2.100 psf	*Division 6 O&M pg 7 of 71.*
Vapor Barrier (SDL)	0.290 psf	*VapAir Seal 725TR Vapor Barrier, Division 6 pg 43 of 92*
5.2" Insulation (SDL)	0.980 psf	*Installed InsulBase Polyiso Carlisle per Architect*
1/2" Densdeck (SDL)	2.000 psf	*DensDeck Roof Board, Division 6 pg 42 of 93*
Single-ply Membrane (SDL)	0.450 psf	*FleeceBack PVC, Division 6 pg 52 of 93*
Σ =	**5.820 psf**	
	**Added to the original roof self-weight and interior finishes/systems.*	

Total CDL + SDL	**Weight**	
CDL =	10.005 psf	**Original + Seismic retrofit CDL*
SDL =	6.879 psf	**Original ceiling + new roofing SDL*
Σ =	**16.885 psf**	

Live/Snow Loads	**Roof**	**Notes**
Roof Live Load =	20 psf	*Per original structural drawings*
Snow Load =	30 psf	*Per seismic retrofit structural drawings*

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Project North Medford Gym Collapse	By KMR	Sheet No. F.1
Location Medford, OR	Date 4/23/25	
Client Medford School District	Revised	Job No.
Appendix F - Snow Loads	Date	

APPENDIX F: SNOW LOADS

kpff Portland, Oregon	Project Medford Gym	By KMR	Sheet No. F.2
	Location Medford, OR	Date 2/25/25	
	Client Medford School District	Revised	Job No.
	2022 OSSC Snow Load Calculation	Date	

Snow Load

$P_g = 4$ psf

Flat Roof Snow Load

$P_f = 0.7\, C_e C_t I_s P_g = (0.7)(0.9)(1.1)(1.1)(4\text{psf}) = 3.05\text{ psf}$

Surface Roughness B → urban/suburban

Fully Exposed Roof

$C_e = 0.9$ (Table 7.3-1)

$C_t = 1.1$ (assumes limited heat on)

$I_s = 1.10$ (Risk Category III)

⟶ Roof is a low-slope roof since slope < 15° (gable roof)

Minimum Low Slope

$P_m = \underset{\uparrow \text{ per OSSC 2022}}{I_s(20\text{psf})} = 1.1(20\text{psf}) = 22\text{psf}$ + rain-on-snow surcharge (5psf)

$P_m = 22\text{ psf} + 5\text{ psf} = \boxed{27\text{ psf}} \longleftarrow$ Roof Design Snow Load

Snow Density

$\gamma = 0.13 p_g + 14 = 0.13(4\text{psf}) + 14 = \underline{14.52\ \text{lb}/\text{ft}^3}$

Depth for Design Load ⟶ $P_d = h_d \times \gamma$, $h_d = P_d/\gamma$

$\text{height} = \dfrac{27\ \text{lb}/\text{ft}^2}{14.52\ \text{lb}/\text{ft}^3} = \underline{\underline{1.85\text{ ft}}}$ Current Code

kpff	Project: Medford Gym Collapse	By: KMR	Sheet No.
	Location: Medford, OR	Date: 04/24/25	
	Client: Medford School District	Revised:	Job No.
	Subject: Snow Loads	Date:	22400083

Load Assumptions

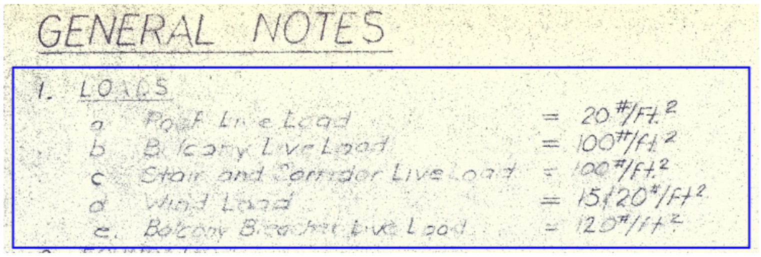
LOAD TYPE: Snow/Roof Live Loads

Live Loads	Weight	Notes
Original Roof Live Load =	20 psf	*Per original structural drawings*
Current Code Roof Live Load =	20 psf	*ASCE 7-16, Table 4.3-1*

--> No change in Roof Live Loads since original construction

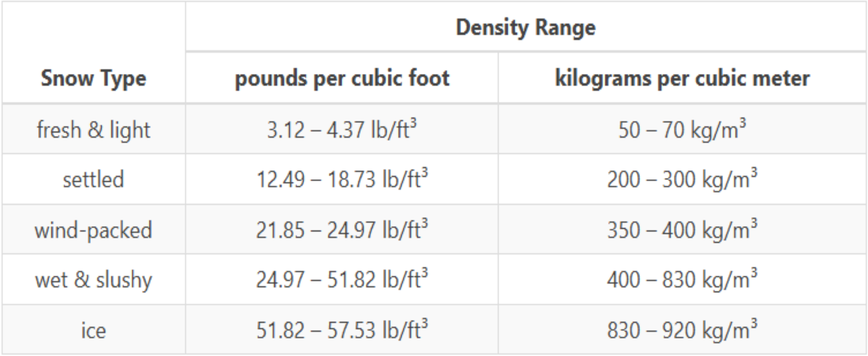
Snow Loads	Density	Weight	Notes
Original Roof Snow Load =	NA	NA	*Not defined in original structural drawings.*
Current Code Snow Load =	14.52 lb/ft^3	27.0 psf	*Per ASCE 7-16 Ch. 7 & 2022 OSSC*

Actual Snow Event	Density	Height	Weight	Notes
Code Roof Snow, High =	14.52 lb/ft^3	6 in	7.3 psf	*Using Current Code Snow Density*
Wet Snow, Low =	24.97 lb/ft^3	6 in	12.5 psf	*Approximation of wet snow weight.*
Wet Snow, High =	51.82 lb/ft^3	6 in	25.9 psf	*Approximation of wet snow weight.*



GENERAL NOTES

1. LOADS
   - a Roof Live Load = 20#/Ft.²
   - b Balcony Live Load = 100#/Ft.²
   - c Stair and Corridor Live Load = 100#/Ft.²
   - d Wind Load = 15/20#/Ft²
   - e. Balcony Bleacher Live Load = 120#/Ft²



Snow Type	Density Range	
	pounds per cubic foot	kilograms per cubic meter
fresh & light	3.12 – 4.37 lb/ft³	50 – 70 kg/m³
settled	12.49 – 18.73 lb/ft³	200 – 300 kg/m³
wind-packed	21.85 – 24.97 lb/ft³	350 – 400 kg/m³
wet & slushy	24.97 – 51.82 lb/ft³	400 – 830 kg/m³
ice	51.82 – 57.53 lb/ft³	830 – 920 kg/m³