Smoot
An Abnormal Unit of Distance
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Chapter 1

Oliver R. Smoot

Oliver Reed Smoot, Jr. (born 1940) was Chairman of the American National Standards Institute (ANSI) from 2001 to 2002 and President of the International Organization for Standardization (ISO) from 2003 to 2004.[1] In 2011 the American Heritage Dictionary admitted his decapitalized surname, "smoot", as one of the 10,000 new words added to their fifth edition. The term is named for Smoot from his undergraduate days when he was used as a unit of measure during a fraternity pledge activity.[2][3]

1.1 Biography

He received his Bachelor of Science from MIT and his Juris Doctor (law degree) from Georgetown University. Smoot, a member of Lambda Chi Alpha fraternity, graduated from MIT with the class of 1962. He is primarily known in Boston, Massachusetts for the smoot marks on the Harvard Bridge, where he was used as a unit of measure for measuring the length of the bridge, as part of a fraternity pledging prank.

Smoot gave a speech to a hearing of the House Science Committee’s Subcommittee on Technology on March 20, 2000, entitled “The Role of Technical Standards in Today’s Society and in the Future”.

He returned to MIT on October 4, 2008 for a 50th anniversary celebration,[4] including the installation of a plaque on the bridge. Smoot was also presented with an official unit of measurement: a smoot stick.[5] On May 7, 2016 he served as the grand marshal of the parade marking the centenary of MIT’s moving from Boston’s Back Bay into Cambridge.[6][7]

1.2 References


1.3 External links

- Speech for the House

- NPR Interview on December 7, 2005, on the occasion of his retirement.

- MIT tribute page - he was featured on MIT’s daily-changing home page on December 19, 2005

Chapter 2

Smoot

This article is about the non-standard unit of measure. For other uses, see Smoot (disambiguation).

The smoot /ˈsmuːt/ is a nonstandard, humorous unit of length created as part of an MIT fraternity prank. It is named after Oliver R. Smoot, a fraternity pledge to Lambda Chi Alpha, who in October 1958 lay down repeatedly on the Harvard Bridge (between Boston and Cambridge, Massachusetts) so that his fraternity brothers could use his height to measure the length of the bridge.[1]

2.1 Unit description

One smoot is equal to Oliver Smoot's height at the time of the prank, 5 feet 7 inches (1.70 m).[2] The bridge's length was measured to be 364.4 smoots (2,035 ft; 620.1 m) plus or minus one ear, with the “plus or minus” intended to express uncertainty of measurement.[3] Over the years the “or minus” portion has gone astray in many citations, including the markings at the site itself, but has now been enshrined in stone by Smoot's college class.[4]

2.2 History

To implement his use as a unit of measure, Oliver Smoot repeatedly lay down on the bridge, let his companions mark his new position in chalk or paint, and then got up again. Eventually, he got tired from all this exercise and was carried thereafter by the fraternity brothers to each new position.[5][6]

Oliver Smoot graduated from MIT with the class of 1962, became a lawyer, and later became chairman of the American National Standards Institute (ANSI, 2001–02) and then, president of the International Organization for Standardization (ISO, 2003–04).[8] He is the cousin of Nobel Prize winner George Smoot. The prank's fiftieth anniversary was commemorated on October 4, 2008 as Smoot Celebration Day at MIT, which Smoot attended.[6]

In 2011, “smoot” was one of the 10,000 new words added to the fifth edition of the American Heritage Dictionary.[9][10] On May 7, 2016, Oliver Smoot served as Grand Marshal of the alumni parade across the bridge, celebrating the 100th anniversary of MIT's move from Boston to Cambridge.[11]

2.3 Practical use

People walking across the bridge today can see painted markings indicating how many smoots there are from where the sidewalk begins on the Boston river bank. The marks are repainted each semester by the incoming associate member class (similar to pledge class) of Lambda Chi Alpha.[12]
Markings typically appear every 10 smoots, but additional marks appear at other numbers in between. For example, the 70-smoot mark is accompanied by a mark for 69. The 182.2-smoot mark is accompanied by the words “Halfway to Hell” and an arrow pointing towards MIT. Each class also paints a special mark for their graduating year.

The markings have become well accepted by the public, to the degree that during the bridge renovations that occurred in the 1980s, the Cambridge Police department requested that the markings be maintained by Lambda Zeta, the MIT chapter of Lambda Chi Alpha which created and maintains the smoot markings, since they had become useful for identifying the location of accidents on the bridge. The renovators went one better, scoring the concrete surface of the sidewalk on the bridge at 5 foot 7 inch intervals, instead of the conventional six feet. The markings continue to be maintained once or twice annually by the undergraduates and alumni of Lambda Zeta.

Google Calculator also incorporates smoots, which it reckons at exactly 67 inches (170.18 cm). Google also uses the smoot as an optional unit of measurement in their Google Earth software and Google Maps distance measurement tool. (In 2014, Google introduced a new Maps interface with a measurement tool that gives distances only in feet/miles and meters/kilometers.)

### 2.4 See also

- List of humorous units of measurement
- List of unusual units of measurement
2.5 References


[7] Oliver R. Smoot

[8] MIT - a salute to Smoot


The 100 smoot mark


2.6 External links

- The Smoot as a unit of length
- The Smoot story, in Oliver Smoot’s own words
- MIT Museum article, with photos at the Wayback Machine (archived August 6, 1997)
- A December, 2005 National Public Radio Interview with Oliver Smoot upon his retirement.
- What’s A Smoot? NPR.org
Smoot mark 69 on the upstream (west) side of the Harvard Bridge
Chapter 3

Harvard Bridge

The Harvard Bridge (also known locally as the MIT Bridge, the Massachusetts Avenue Bridge, and the “Mass. Ave.” Bridge) is a steel haunched girder bridge between Back Bay, Boston and Cambridge, Massachusetts, United States, carrying Massachusetts Avenue (Route 2A) over the Charles River. It is the longest bridge over the Charles River at 659.82 meters (2,164.8 ft; 387.72 sm).[1] It is locally known for being measured, inaccurately, in the idiosyncratic unit of length called the smoot.[5][6]

After several legislative attempts fraught with antipathy on the part of Boston, it was built jointly by Boston and Cambridge, Massachusetts, between 1887 and 1891.[7] It originally included a swing span. The bridge was revised over the years until its superstructure was completely replaced in the late 1980s due to unacceptable vibration and the collapse of a similar bridge. The bridge was named for the Reverend John Harvard.[8]

3.1 Conception

In the Acts of 1874, the Massachusetts Legislature passed Chapters 175 and 314 to authorize the construction of a bridge between Boston and Cambridge.[9] Nothing further happened until 1882, when a follow-up law, Acts of 1882, Chapter 155, with more specifics was enacted. The location was expressed as[10]

Acts of 1882, Chapter 155, Section 1: The cities of Boston and Cambridge are authorized to construct a bridge and avenue across Charles river, from a point on Beacon street, in Boston, to a point in Cambridge, west of the westerly line of the Boston and Albany railroad. ... to the limitation that the line thereof shall not be north-east of a line drawn from the junction of Beacon street and West Chester park, in Boston, to the junction of the harbor line with Front Street, extended, in Cambridge, nor south-west of a line drawn from the junction of Beacon street, Brookline avenue and Brighton avenue, in Boston, to the junction of the Boston and Albany railroad with Putnam avenue, extended, in Cambridge.

The bridge was to have a draw with an opening of at least 38 feet (12 m; 6.8 sm).[10] Boston did not like this Act, mainly because it did not provide for an overhead crossing of the Grand Junction Branch of the Boston and Albany Railroad. So nothing happened until the Act was amended by Acts of 1885, Chapter 129, which changed the draw to a clear opening of at least 36 feet (11 m; 6.4 sm) and no more, until the other bridges below the proposed location were required to have a larger opening.[11] Still nothing happened, until the City of Cambridge petitioned the Massachusetts Legislature in 1887 to compel Boston to proceed. This resulted in Acts of 1887, Chapter 282, which was mandatory for both cities. It required that each city pay for half the bridge, and allowed Boston to raise up to US$250,000 (US$6,660,000 with inflation[12]) for this purpose, in excess of its debt limit. This implied an estimated cost of US$500,000 (US$13,300,000 with inflation[12]) for the bridge.

The Act authorized a commission to build the bridge. The commission was to consist of the mayors of Boston and Cambridge plus one additional person to be appointed by the mayors. If the mayors failed to appoint a third commissioner,
the governor was to do it for them.\[13\] The mayors of Boston and Cambridge, Hugh O’Brien and William E. Russell, appointed Leander Greeley of Cambridge as the third commissioner.\[14\] This changed over time.\[15\]

The expectations of having built the bridge were clear.\[16\]

The effect that the bridge will have upon both cities is obvious. The low land and marshes on the Cambridge side, formerly almost valueless, have been filled in and have become valuable; and Cambridge is now connected with the choicest residential portions of Boston. The residents of the Back Bay, South End, Roxbury, and other southern sections of Boston are now connected directly, by way of West Chester park and the bridge, with Cambridge, Belmont, Arlington, and adjacent towns; and this thoroughfare in Boston, it is believed, will ultimately be the central one of the city.

3.2 Engineering

![Postcard showing Harvard Bridge looking toward Boston in 1910, from the roof of the Riverbank Court Hotel (now Maseeh Hall, an MIT dormitory)](image)

The Acts of 1887 declared the bridge to be a wooden pile structure with stone pavement for the first 200 feet (61 m; 36 sm) because the Charles River Embankment extension was expected to take that space, but that was changed such that the whole distance would be of iron spans on stone piers. The general plans were approved on 14 July 1887.\[18\] The engineers were William Jackson (Boston City Engineer), John E. Cheney (assistant Boston City Engineer), Samuel E. Tinkham (assistant engineer), and Nathan S. Brock (assistant engineer at bridge).\[19\]

The subsurface conditions at the bridge location are extreme. Much of Boston is underlain with clay, but the situation at the bridge is exacerbated by a fault which roughly follows the path of the Charles River itself. From a depth of approximately 200 to 300 feet (60 to 90 m; 40 to 50 sm) below existing ground, is a very dense till composed of gravel and boulders with a silt-clay matrix. Above that to approximately 30 feet (9 m; 5 sm) below the surface is Boston blue clay (BBC). Over this are thin layers of sand, gravel, and fill. The BBC is overconsolidated up to a depth of approximately 70 feet (20 m; 10 sm).\[3\]
The substructure originally consisted of two masonry abutments and twenty-three masonry piers, as well as one pile foundation with a fender pier for the draw span. The superstructure was originally twenty-three cantilevered fixed spans and suspended spans, of plate girders with one swing span.[20] The Boston abutment rests on vertical piles, while the Cambridge end is directly on gravel.[3]

Originally, the bridge was built across the Charles River connecting West Chester Park, in Boston, with Front Street, in Cambridge. This is now called Massachusetts Avenue on both sides of the river. As originally built, the total length between centers of bearings on abutments was 2,164 feet 9 inches (659.82 m; 387.72 sm) with a draw 48 feet 4 inches (14.73 m; 8.66 sm) wide between centers. The width of the bridge was 69 feet 4 inches (21.13 m; 12.42 sm) except near and on the draw.[21]

The bridge as built was composed of fixed and suspended spans roughly 75 feet (23 m; 13.4 sm) long and piers 90 feet (27 m; 16 sm) apart, center to center.[22] The span lengths alternated between 75 and 105 feet (23 and 32 m; 13.4 and 18.8 sm). The longer spans were cantilevered, while the shorter spans were suspended between the cantilevers.[3]

The original roadway contained two lanes for horse-drawn vehicles and two street car tracks, for a total width of 51.0 feet (15.5 m; 9.13 sm). There were also two 9-foot-2-inch (2.79 m; 1.64 sm) sidewalks.[7] The original roadway and sidewalk stringers were of wood, with an approximately 1.25-inch (32 mm; 0.0187 sm) thick covering of asphalt on the sidewalk and a 2-inch (51 mm; 0.030 sm) spruce wearing surface on the roadway.[7]

The exception was at the swing span, which was 48 feet (15 m; 8.6 sm) wide. This span was approximately 149 feet (45 m; 26.7 sm) long, and sat on a wooden pier. It was a double-cantilevered, electrically-driven structure also carrying a bridge caretaker’s house.[7]

The bridge opened on 1 September 1891.[4] The original cost of construction to 1 March 1892 was US$510,642.86.[23] This is equivalent to US$13,610,000 with inflation.[12]
3.3 Naming

The bridge was named for the Reverend John Harvard, for whom Harvard University is also named, rather than after the university itself. Other names suggested included Blaxton, Chester, Shawmut, and Longfellow. Possibly due to its proximity to the bridge, there have been a number of tales reported at MIT as to how the bridge came to be named “Harvard”, all apocryphal. The Harvard Bridge was first constructed in 1891. MIT did not move to its current location adjacent to the bridge until 1916.

3.4 Maintenance and events

Harry Houdini jumps from the bridge (1908)

In 1898, 3-foot (0.91 m; 0.54 sm)-wide bicycle lanes were installed next to each curb. In 2011 (113 years later), the City of Boston finally connected these lanes to its own bike lanes.

According to a marker near the southeast end of the bridge, Harry Houdini performed one of his “well known escapes” from this bridge on 1 May 1908. Other sources have it as 30 April 1908.

The bridge was declared unsafe in 1909, requiring all of the iron and steel to be replaced. The draw was elevated slightly and the trolley rails were replaced as well.

When the Metropolitan District Commission (MDC) took control of the bridge in 1924, they rebuilt much of the bridge superstructure. They replaced the wooden stringers with steel “I” beams, topped wooden deck elements with concrete and brick, and replaced the street car rails. Structural steel hangers replaced wrought iron. The swing span was converted into two 75-foot (23 m; 13.4 sm) fixed spans the same width as the rest of the bridge. The wooden pier was heavily modified with concrete and stone to make it resemble the other piers, increasing the number of stone piers from 23 to 24.

Heavy traffic at the Mass Ave and Memorial Drive intersection on the Cambridge end of the bridge led to the construction of an underpass in 1931.

The bridge was formerly referred to as the “Xylophone Bridge” because of the sound its wooden decking made when traffic traveled over it. This decking was replaced in 1949 with 3-inch (76 mm; 0.045 sm) concrete-filled “I-beam lok” grating topped with a 2.25-inch (57 mm; 0.0336 sm) thick bituminous wearing surface. At this time, all bearings were replaced, and the trolley car tracks were removed, as were granite blocks. The trolley car poles were reused for street lights. Ramps between the bridge and the under-construction Storrow Drive were added.
The 1924 sidewalk slabs were replaced by precast, prestressed slabs in 1962.\textsuperscript{[5]} The fifteen expansion dams were replaced or repaired in 1969.\textsuperscript{[29]}

### 3.4.1 Engineering study, 1971-1972

The Harvard Bridge is decorated with both serious and comical statements of art.

An engineering study was performed by the Metropolitan District Commission (later merged into the Department of Conservation and Recreation) in 1971-1972 due to complaints by bridge users of excessive vibration.\textsuperscript{[5][30]} The bridge was found to be understrength for its load. Before the final study was complete, the recommendation was to place a load limit of 8 short tons (7.3 t) per axle and a total of 15 short tons (14 t) per vehicle, or to restrict trucks to the interior lanes, where the bridge was stronger. A 25-short-ton (23 t) limit was imposed.\textsuperscript{[31]}

Suggestions made included strengthening the existing structure by adding either struts or plates to make the existing four beams along the length of the bridge into a stiffening truss, or to replace the superstructure with a new one, made of either steel or concrete, which would be up to current standards.\textsuperscript{[30]} The recommendation was to replace the superstructure with one weighing approximately the same in order to reuse the piers, which were in good condition.\textsuperscript{[31]}

The reasoning was that the cost of a new structure could be predicted much more easily than the cost of repairing and reinforcing the existing bridge. The resulting new bridge would be of known materials and quality, such as ductile structural steel rather than brittle wrought iron, and rated at AASHO HS-20. Repairing the existing structure would leave old wrought iron of uncertain quality and condition standing, and would not bring the design up to (then) current standards.\textsuperscript{[31]} Detailed engineering calculations were included.\textsuperscript{[32]} The price was estimated at US$2.5 million to US$3 million\textsuperscript{[31]} (US$14,000,000 to US$17,000,000 with inflation\textsuperscript{[12]}).

The action taken based on this study was to establish load restrictions on the bridge, 15 short tons (14 t) in the outer lanes,
25 short tons (23 t) on the inner lanes. This was expanded in 1979 to a flat limit of 15 short tons (14 t) on the whole bridge.\[33\]

### 3.4.2 Superstructure replacement, 1980s

After the failure of the Mianus River Bridge at Greenwich, Connecticut in 1983, the Harvard Bridge was shut down and inspected because it contained similar elements, specifically the suspended spans.\[34\][35] Traffic was restricted to the inner two lanes due to the discovery of two failed hangers on span 14. A few days later, all trucks and buses were banned from the bridge.\[33\]

In 1986, a report was published containing the plan to replace the superstructure on the existing supports. Alternatives considered were very similar to the 1972 report, and were similarly decided.\[36\] Structural modifications included an upgrade from four longitudinal girders to six of the same shape and replacement of a stairway with a handicapped pedestrian ramp on the Boston end of the bridge.\[37\]

Ramp “B”, from southbound (Boston bound) bridge lanes to eastbound Storrow Drive, caused traffic to merge onto Storrow Drive from the left (high speed) lanes using a short acceleration lane, causing safety issues. The MDC requested elimination of this ramp. Compared to overall bridge traffic of 30,000 vehicles per day, traffic on ramp B was found to be low, approximately 1,500 vehicles per day with a peak of 120 vehicles per hour.\[38\]

The historic value of the bridge was considered significant, so the plan was to make the replacement superstructure appear similar, with similar railing and lighting. In order to document the pre-existing structure, a Historic American Engineering Record (HAER) would be prepared.\[39\]

Pier 12 was exhibiting inappropriate movement and was scheduled for reinforcement.\[40\]

The work would be done in two phases. Phase 1 would reinforce the downstream side of the bridge to allow MBTA bus traffic, and was expected to take 5 months. Most of this effort would be spent on the underside of the bridge and would not affect existing traffic. Phase 2 would replace the entire superstructure and was expected to take three construction seasons to implement. Cost was estimated to be US$20M\[40\] (US$44,000,000 with inflation). Phase 1 finished in 1987, and Phase 2 in 1990.\[41\]

- Before-and-after images

  ![Before-and-after images](image1)

  Bridge viewed from the upstream Cambridge side in 1985. Construction barrels restricting traffic from the outside lanes, and general wear and tear are visible (click on image to enlarge)

  ![Before-and-after images](image2)

  Roughly the same view, in 2009. Superstructure is in much better shape only 20 years after completion, than the 1985 superstructure was roughly 40 years after its most recent major work.
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3.4.3 Subsequent events

In the Fall of 2014, the Charles River Conservancy announced that an anonymous donor would fund an upgrade of the street lights for both the roadway and both sidewalks on the bridge. The new roadway and aesthetic lighting will be installed in 2015, highlighting the smoot marks along the sidewalk. The design was selected after a competition won by Miguel Rosales of Rosales + Partners. The light posts will be located 30 smoots (167.5 ft; 51.05 m) apart. “It will provide safe lighting for pedestrians and drivers, and the elements of design on the bridge will be pulled out and emphasized. It will become a really beautiful bridge,” said Renata von Tscharner, founder and president of the Charles River Conservancy.

3.5 Bridge length measurement

Main article: Smoot

The Harvard Bridge is measured, locally, in smoots. In 1958, members of the Lambda Chi Alpha fraternity at MIT measured the bridge’s eastern sidewalk by using that year’s shortest pledge, Oliver Smoot—nominally, 5 feet 7 inches (1.70 m) tall—as a measuring stick. Years after this stunt, Smoot became president of the American National Standards Institute (ANSI), and later president of the International Organization for Standardization (ISO). Markers painted at 10-smoot (55.83 ft; 17.02 m) intervals give the bridge’s length 364.4 smoots long, “plus one ear”. Originally this read “plus or minus one ear”—representing measurement uncertainty—but over the years the words “or minus” disappeared. The marks are repainted twice each year by members of the fraternity—originally surreptitiously and later openly.

During the major reconstruction in the 1980s, the new sidewalks were divided into smoot-length slabs rather than the standard six feet, and the smoot markings were painted on the new deck. Officials’ original determination to omit the smoot markings from the reconstructed bridge, and to scrupulously prevent the fraternity from repainting them, evaporated when it was realized that police routinely used the smoot marks as reference points in accident reports.

The nominal length of 364.4 smoots (from two designated points at the bridge’s ends) corresponds to about 2030 feet or 620 m, somewhat less than the bridge’s published length of 660 meters (2,170 ft; 390 sm).
3.6 **See also**

- List of crossings of the Charles River
### 3.7 Notes

[1] For an example of the alternative, see Boston University Bridge.

[2] The structure now called the Longfellow Bridge opened 15 years later, and was given its current name in 1927.

### 3.8 References

[1] Harvard Bridge at *Structurae*


[3] HAER, p.4


[5] HAER, p. 5


[7] HAER, p. 3


[17] “Recent Deaths”. *Boston Evening Transcript*. Boston, Massachusetts: Boston Transcript Company. 16 February 1891. p. 2. Retrieved 17 April 2012. Mr. Leander Greeley, a prominent master builder of Boston and Cambridge and one of the three Harvard Bridge Commissioners, died this morning. Mr. Greeley, who in health was a man of fine physique, had of late been subject to ailments for which he had sought Florida as a relief. He was an enterprising and public-spirited citizen of Cambridge, where he had often been called by the public to positions of trust. He was also a working member of several benevolent orders. There are many monuments of his skill as a builder in and about Boston, including many churches. The Master Builders’ Association will sincerely mourn his loss. He was about sixty years old and leaves a family.


3.8. REFERENCES


[27] “Famous Harvard Bridge Unsafe” (pdf). New York Times. 16 July 1909. Retrieved 2012-03-20. The famous Harvard Bridge connecting Cambridge and Boston was declared to be unsafe in a report made to-day by a commission of Boston and Cambridge engineers, and announcement was made that work would be started on Monday next to strengthen the structure. The commission finds that all of the iron and steel beams of the bridge, which is nearly three-quarters of a mile long, will have to be replaced by new ones, at the same time the draw will be elevated slightly, and new surfacing will be put on. The Boston elevated railway company, which operates its cars across the bridge, is ordered to install new rails and new supports.


[29] HAER, p.6
[30] Leet, phase 2
[31] Leet, phase 3
[32] Leet, phase 3, appendices
[33] HAER, p.8


[36] Replacement, p.7
[37] Replacement, p.4
[38] Replacement, page 4-6
[39] Replacement, p.11. Note the use of the HAER document throughout this article.
[40] Replacement, page 5


[44] https://slice.mit.edu/2014/10/21/smoot-lights-harvard-bridge/


Fahrenthold, David A. (8 December 2005). “The Measure of This Man Is in the Smoot”. Washington DC: The Washington Post. Retrieved 2009-04-20. And then there was a little help from the government: When the bridge was renovated about 15 years ago, officials agreed to let the markings stay, even going so far as to score the sidewalk at 5-foot-7 Smoot intervals instead of the usual six-foot ones.

Brehm, Denise (1 September 1999). “Keyser describes his top five hacks - MIT News Office”. *MIT News*. Cambridge, Massachusetts: Massachusetts Institute of Technology. Retrieved 2012-03-04. When the bridge was rebuilt in the 1980s, the Cambridge police requested that the smoots remain because they use them to indicate precise locations in accident reports.

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- Historic American Engineering Record (HAER) No. 13-BOST, "Harvard Bridge, Spanning Charles River at Massachusetts Avenue, Boston, Suffolk County, MA", 58 photos, 63 data pages, 4 photo caption pages

3.10 External links

- Harvard Bridge at *Structurae*
- 1895 photo
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- **Smoot**

- **Harvard Bridge**

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