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# Effects of Jackhammer Weight on Bridge Deck Preparation Prior to Overlay

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**Topic/Problem Statement:** Effect of 60-pound jackhammers vs. 35-pound jackhammers on preparation of a bridge deck surface prior to overlay, especially relating to damage sustained by the concrete and rebar in the bridge deck.

**Keywords:** Jackhammer, jack hammer, pneumatic breaker, surface preparation, bridge deck overlay.

## Summary

We found one citation for a research project directly related to the issue of jackhammer weight: a 2002 Missouri DOT study.

Because we were unable to identify any other published research on this topic, we have included excerpts from 14 state specifications on surface preparation prior to placement of a bridge deck overlay. Of the specifications we located related to concrete removal on bridge decks (especially prior to overlay):

- Seven agencies (five states and two Canadian provinces) limit jackhammer weight to 30 to 35 pounds or less.
- Two agencies limit jackhammer weight to 45 pounds or less. In addition, one national research report (a 1992 report of the Strategic Highway Research Program) references 45 pounds as a common cutoff among state agencies.
- One agency limits jackhammer weight to 60 pounds or less.
- Four agencies allow flexibility in jackhammer weight based on engineering judgment.

## Citations

*Links to online copies of cited literature are provided when available. Contact the WisDOT Library to obtain hard copies of citations.*

**Title: Effects of Heavyweight Jackhammer**
**Author(s):** Missouri DOT
**Date:** December 2002
**Source/URL:** Report no. RI 98-021; http://library.modot.mo.gov/RDT/reports/Ri98021/RDT02003.pdf

**Description:** 59 pages
**Contents:** The objective of this study is to determine the extent of damage, if any, of using a heavyweight jackhammer, 65 lb., as opposed to a lighter weight jackhammer, 35 lb., for removing deteriorated concrete during bridge deck repair. The use of a heavier weight jackhammer allows more efficient and timely repair operations. However, there are questions of potential damage to the bridge deck when using a heavyweight jackhammer. In conjunction with the above findings it was determined that allowing the use of 65 lb. jackhammers for contracted maintenance repair projects (on un-programmed bridges) is not in conflict with the Missouri Department of Transportation's special provisions limiting operations to a maximum 35 lb. jackhammer on bridge rehabilitation construction contracts.

## State Specifications

### States Limiting Jackhammers to 30-35 lbs. or Less

**Title: Bridge Deck Preparation and Resurfacing**
**Author(s):** South Dakota DOT
**Date:** (undated)
**Source/URL:** www.sddot.com/operations/docs/specbook04/550.pdf, page 3
**Description:** 16 pages
**Excerpt:**
From page 3 of the PDF:

> **550.3 Construction Requirements**
> B. Equipment: Equipment for deck preparation, mixing, placing, and finishing of latex modified concrete or low slump dense concrete shall be approved prior to start of work.
> 1. Surface Preparation: Surface preparation equipment shall consist of the following:
> c. Power driven hand tools for concrete removal on the bridge deck will be limited by the following:
> 1) Jack hammers heavier than 30 pound (14 kilograms) will not be permitted.

**Title: Specifications for Bridge Construction, Section 20: Deck Overlay and Concrete Rehabilitation**
**Author(s):** Alberta Ministry of Transportation
**Date:** (undated)
**Source/URL:** http://www.transportation.alberta.ca/Content/docType246/Production/07bcs20.pdf, page 3
**Description:** 12 pages
**Excerpt:**
From page 3 of the PDF:

> **20.3 Preparation Work**
> Bridge deck preparation includes but is not limited to all work necessary on the bridge deck prior to overlay concrete placement.
>
> "Jack Hammers" heavier than nominal 14 kg class and "Chipping Hammers" heavier than nominal 7 kg shall not be used.

**Title: Bridge Deck Surfacing, Repair, and Overlay**
**Author(s):** Iowa DOT
**Date:** (undated)
**Source/URL:** http://www.iowadot.gov/erl/current/GS/content/2413.pdf, page 2
**Description:** 10 pages
**Excerpt:**
From page 2 of the PDF:

> **2413.03 CONSTRUCTION.**
> **A. Equipment.**
> Use equipment approved by the Engineer and complying with the following:

**2. Preparation Equipment.**
Use the following types of preparation equipment:

**c. Power Driven Hand Tools.**
Power driven hand tools will be permitted with the following restrictions:

1. Do not use jack hammers heavier than nominal 30 pound class (14 kg)
2. Do not operate jack hammers or mechanical chipping tools at an angle exceeding 45 degrees measured from the surface of the deck.
3. Do not use chipping hammers heavier than a nominal 15 pound (7 kg) class.

**Title: Structures**
**Author(s):** Washington State DOT
**Date:** (undated)
**Source/URL:** http://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/Division6.pdf, page 173
**Description:** 248 pages
**Excerpt:**
From page 173 of the PDF:

**6-09 MODIFIED CONCRETE OVERLAYS**

6-09.3 Construction Requirements
6-09.3(1) Equipment
6-09.3(1)A Power Driven Hand Tools
Power driven hand tools may be used for concrete scarification in areas not accessible to scarification machines, and for further deck preparation work, except for the following:

1. Jack hammers more forceful than the nominal 30-pound class.
2. Chipping hammers more forceful than the nominal 15-pound class.

The power driven hand tools shall be operated at angles less than 45-degrees as measured from the surface of the deck to the tool.

**Title: Concrete Bridge Deck Overlays**
**Author(s):** Texas DOT
**Date:** June 2004
**Source/URL:** http://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/specs/2004/standard/s439.pdf; page 3
**Description:** 5 pages
**Excerpt:**
From page 3 of the PDF:

**439.4. Construction.**
**B. Surface Preparation.**
Use a jackhammer not heavier than a nominal 30-lb. class to remove deteriorated concrete in small areas not accessible to the mechanical scarifier, and to spot-remove small areas of deteriorated concrete to a depth down to the existing top reinforcing steel. This class of jackhammer may also be used for concrete removal between existing reinforcing bars to a greater depth. Use chipping hammers not heavier than a nominal 15-lb. class to remove concrete from beneath any reinforcing bars. Avoid cutting, stretching, or damaging exposed reinforcing steel by direct impact of these power tools. Repair or replace reinforcing steel damaged during the concrete removal process at no additional expense to the Department. Operate all jackhammers and chipping hammers at an angle of 45° or less measured from the surface of the slab.

**Title: Construction Specification for Structure Rehabilitation—Concrete Removal**
**Author(s):** Ontario Ministry of Transportation
**Date:** June 2010
**Source/URL:**
http://www.raqsa.mto.gov.on.ca/techpubs/cdedsp.nsf/7df9b6224fbd62b785257173004de677/008c0a8799b2613a852570de006943f1/$FILE/SSP%20109S49%20-%20June%202010.pdf, page 4
**Description:** 14 pages

**Excerpt:**
From page 4 of the PDF:

> **928.06 EQUIPMENT**
> 928.06.02 Air Hammers
> Air hammers shall be hand held and meet the following requirements:
> b) Jack hammers shall have a maximum weight of 14.0 kg.

**Title: Supplemental Specification 848: Bridge Deck Repair and Overlay with Concrete Using Hydro-Demolition**
**Author(s):** Ohio DOT
**Date:** April 2005
**Source/URL:**
http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/848_04152005_for_2008.PDF, page 5
**Description:** 17 pages
**Excerpt:**
From page 5 of the PDF:

> **848.11 Hydro-demolition Equipment.** The hydro-demolition equipment shall be a self-propelled machine that utilizes a high pressure water jet stream capable of removing concrete to the depth specified herein and/or as shown on the plans and be capable of removing rust and concrete particles from reinforcing steel. Hand held high pressure [10,000 psi (690 bar) minimum] wands or 35 lb (16 kg) maximum jackhammers operated at no more than a 45 degree angle from horizontal shall be used in areas that are inaccessible to the self-propelled machine or in patching areas that require work to remove the remaining unsound concrete.

**States Limiting Jackhammers to 45 lbs. or Less**

**Title: Bridge Deck Repair**
**Author(s):** Indiana DOT
**Date:** (undated)
**Source/URL:** http://www.in.gov/indot/files/bridge_chapter_07.pdf, page 20
**Description:** 48 pages
**Excerpt:**
From page 20 of the PDF:

> **OVERLAY DAMS**
> When bridge decks are to be overlaid, overlay dams may be constructed regardless of the type of expansion joint or roadway drain to be installed. This work consists of removing the existing concrete from the bridge floor around the joint or drain and replacing the concrete with new concrete according to the plans or as directed by the PE/PS. This work is described as follows:
>
> 2) Power-driven hand tools for removal by handchipping are permitted with the following exceptions:
> a. [Jack] hammers heavier than nominal 45 lb class may not be used

**Title: Bridge Deck Latex Concrete Overlay**
**Author(s):** Illinois DOT
**Date:** Revised January 2011
**Source/URL:** http://www.dot.state.il.us/bridges/gbsp30.pdf, page 3
**Description:** 10 pages
**Excerpt:**
From page 3 of the PDF:

**Equipment:** The equipment used shall be subject to the approval of the Engineer and shall meet the following requirements:

(a) **Surface Preparation Equipment.** Surface preparation equipment shall be according to the applicable portions of Section 1100 and the following:

(7) **Power-Driven Hand Tools.** Power-driven hand tools will be permitted including jackhammers lighter than the nominal 45 lb. (20 kg) class. Jackhammers or chipping hammers shall not be operated at an angle in excess of 45 degrees measured from the surface of the slab.

**Title: Techniques for Concrete Removal and Bar Cleaning on Bridge Rehabilitation Projects**
**Author(s):** Strategic Highway Research Program; Michael C. Vorster, James P. Merrigan, Robert W. Lewis, Richard E. Weyers, Virginia Polytechnic Institute & State University
**Date:** December 1992
**Source/URL:** Report no. SHRP-S-336, http://onlinepubs.trb.org/onlinepubs/shrp/SHRP-S-336.pdf, page 31
**Description:** 129 pages
**Contents:** The report addresses the partial removal of concrete from decks and other parts of bridge structures. It is intended as a practical guide for state highway agency and contractor personnel who face the challenge of using new and appropriate technologies for concrete removal and bar cleaning on bridge rehabilitation projects. The required removal tasks are classified in terms of the method used to identify the removal area, the size and location of the removal area and the depth of removal.

A variety of concrete removal techniques are analyzed in terms of their ability to perform one or more of the removal tasks. Three technologies are identified as being of particular importance and these are studied in detail: pneumatic breakers, milling and hydrodemolition.

The detailed analysis of the three technologies is done in a uniform format addressing work characteristics, production, cost and quality of product. This permits a comparative analysis of the three technologies and makes it possible to identify their strengths and weaknesses and to make recommendations with regard to the manner in which they can be combined to achieve a desired result.

**Excerpt:**
From page 31 of the PDF:

> SHAs typically limit the weight of breakers that can be used for selective concrete removal to less than 45 pounds (20 kg) to minimize residual cracking and preserve the bond between the residual concrete and the repair concrete in areas that are not removed. The angle of attack measured from the breaker's axis to the concrete surface is also frequently limited to 45 degrees for the same reasons. The skill of the operator is important with regard to both the quantity and quality of the work performed. This factor must not be overlooked when assessing the viability of the method.

**<u>States Limiting Jackhammers to 60 lbs. or Less</u>**

**Title: Concrete Bridge Deck Repair with High Density-Low Slump Concrete**
**Author(s):** Nebraska Department of Roads
**Date:** (undated)
**Source/URL:** http://www.dor.state.ne.us/ref-man/specbookm/700/700-m111.pdf, page 2
**Description:** 12 pages
**Excerpt:**
From page 2 of the PDF:

> **711.03 -- Equipment**
> 2. Surface preparation equipment shall be of the following types:
> d. Power-driven hand tools will be allowed with the following restrictions:
> (1) Jackhammers with a mass greater than a nominal 27 kg class shall not be used.

**States That Allow Flexibility in Jackhammer Weight**

**Title: DelDOT Bridge Design Manual, Chapter Nine: Rehabilitation of Existing Bridges**
**Author(s):** Delaware DOT
**Date:** May 2005
**Source/URL:** http://www.deldot.gov/information/pubs_forms/manuals/bridge_design/pdf/bdm-09-rehabilitation.pdf; page 9 of the PDF
**Description:** 56 pages
**Excerpt:**
From page 9 of the PDF:

> **9.3.1.3 Concrete Removal**
> Three methods are used for removal of concrete for rehabilitation of decks:
> • jackhammer,
> • hydrodemolition, and
> • milling.
>
> **Jackhammer.** The size of the jackhammer must be appropriate for the amount of removal to prevent unnecessary damage to the deck.

**Title: Area Prepared for Patching (Existing Concrete Bridge Decks)**
**Author(s):** Kansas DOT
**Date:** 2007
**Source/URL:** http://www.ksdot.org/burConsMain/specprov/2007/731.pdf, page 1
**Description:** 4 pages
**Excerpt:**
From page 1 of the PDF:

> **731.3 CONSTRUCTION REQUIREMENTS**
> Unless specifically noted in the Contract Documents, the Contractor may choose to remove unsound concrete by hydrodemolition or by other means capable of removing the required concrete, without injury to the sound concrete and reinforcing steel. Do not use jack hammers or chipping hammers heavier than the nominal 15 pound class on any partial depth concrete removal. Jack hammers up to the nominal 30 pound class may be used in areas of full depth patching to within 6 inches of the edges of the designated areas. Do not use chipping hammers heavier than a nominal 15 pound class to remove the 6 inch edge. Operate jack hammers and chipping hammers at an angle to prevent damage to the sound concrete.

**Title: Latex Modified Concrete Mix Design**
**Author(s):** FHWA (review of anonymous state DOT procedure)
**Date:** February 2008
**Source/URL:** http://www.fhwa.dot.gov/construction/reviews/revlmc3.cfm
**Description:** Website
**Excerpt:**

> **Deck Preparation**
> Jackhammers of 30kg/60 lbs for initial removal operations
> Smaller chippers of 15kg/30lbs or smaller if the project manager feels that larger hammers are detrimental to bridge deck.
> Operation of jackhammers no more than 60% from horizontal.

**Title: Bridge Deck Preservation Procedures for the Arizona Department of Transportation**
**Author(s):** Arizona DOT
**Date:** February 2006
**Source/URL:** http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ520.pdf, page 36

**Description:** 42 pages
**Excerpt:**
From pages 35-36 of the PDF:

> **X03.03 EQUIPMENT.** The equipment used shall be subject to the approval of the Engineer and shall meet the following requirements:
>
> **X03.03.1 Surface Preparation Equipment.** Surface preparation and concrete removal equipment shall be according to the applicable portions of Sections 202 and 601 of the Standard Specifications and the following:
>
> **c. Power-Driven Hand Tools.** Power-driven hand tools will be permitted, including light-weight jackhammers. Chipping hammers heavier than a nominal 15-lb class shall not be used for final removal at the boundary of full-depth repairs. Jackhammers or chipping hammers shall not be operated at an angle in excess of 45 degrees measured from the surface of the deck.

## Related Research

**Title: Hydrodemolition and Repair of Bridge Decks**
**Author(s):** Missouri DOT
**Date:** December 2002
**Source/URL:** Report no. RI 97-025; http://library.modot.mo.gov/RDT/reports/Ri97025/RDT02002.pdf
**Description:** 37 pp.
**Contents:** The use of modern hydrodemolition equipment for removal of deteriorated concrete and preparation of bridge decks for concrete repair is the subject of this report. A comparison is made of hydrodemolition to conventional sawing and jackhammer removal concerning cost and harm to the remaining concrete.