KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 1990 EDITION

NOTE: This special provision is generally written in the imperative mood. The subject, "the *Contractor*" is implied. Also implied in this language are "*shall*", "*shall be*", or similar words and phrases. The word "*will*" generally pertains to decisions or actions of the Kansas Department of Transportation.

Create a new subsection in Section 700, Structures, titled "Silica Fume Overlay".

SECTION 700

SILICA FUME OVERLAY

1.0 DESCRIPTION.

Furnish materials for, and construct a wearing course of silica fume modified Portland cement concrete on the prepared surface of reinforced concrete bridge decks. Place the overlay according to the grades, thickness and cross-sections shown on the Plans.

BID ITEMS	**UNIT**
Silica Fume Overlay (*)	square meter
Material for Silica Fume Overlay	cubic meter (Set Price)

* Denotes Thickness

2.0 MATERIALS.

a. Portland Cement.

(1) Portland Cement, Standard Specifications, Subsection 2001, except only Type IP, Type II or Type I/II is permitted.

(2) Fly Ash modified concrete will not be permitted.

b. Coarse Aggregate. Standard Specifications, Subsection 1102.02(a). Add the following:

(1.3) *Coarse Aggregate for Bridge Deck Overlays.* Use naturally occurring crushed stone aggregates conforming to the following requirements.

Soundness, minimum	0.95.
Wear, maximum	40%.
Acid Insoluable Residue,minimum	55%.

Page 730, Table 1, Add the following:

TABLE 1-GRADING REQUIREMENTS for COARSE AGGREGATES for CONCRETE

Aggregate Designation	Usage	Composition	Percent Retained - Square Mesh Sieves							
			37.5 mm	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	800 μm
CA-7	Bridge Deck Overlay	Siliceous Gravel, Chat, or Calcite Cemented Sandstone			0	0-10	15-50	85-100		

c. Fine Aggregates. Standard Specifications, Subsection 1102, Type FA-A.

d. Water. Standard Specifications, Subsection 2401.

e. Curing Materials. Standard Specifications, Section 1400 and as specified in **3.0 e.** of this Special Provision.

f. Admixtures.
(1) Air Entraining Admixture. Standard Specifications, Section 1400.
(2) Water Reducing or Plasticizing Admixture. Standard Specifications, Section 1400.

g. Precure / Finishing Aid Material. Standard Specifications, Section 1400 (90M-224, latest revision).

h. Silica Fume. Standard Specifications, Section 1400 (90M-158, latest revision).

i. Concrete Masonry Coating. Standard Specifications, Section 1700 (90M-209, latest revision).

3.0 CONSTRUCTION REQUIREMENTS.

a. Equipment. Equipment is subject to approval of the Engineer and must comply with the following:

(1) Surface Preparation Equipment.

Use sand-blasting, shot-blasting, or water jetting equipment capable of removing rust, oil, dirt, loose disintegrated concrete and concrete laitance from the existing surface of the bridge deck. Wet sand blasting may be used only with permission of the Engineer.

(2) Proportioning and Mixing Equipment. Section 401 of the Standard Specifications.

(3) Placing and Finishing Equipment.

(a) Include adequate hand tools for placement of plastic concrete and for working down to approximately the correct level for striking-off with the finishing screed.

(b) Use a finishing machine consisting of a mechanical strike-off capable of providing a uniform thickness of concrete slightly above finish grade in front of an oscillating screed or screeds. The finishing machine will be inspected and approved by the Engineer before work is started on each project.

(c) Use at least one oscillating screed capable of consolidating the concrete by vibration to 100 percent of the vibrated unit mass with the following features:

- Identical vibrators installed such that at least one vibrator is provided for each 1.5 m of screed length.
- Bottom face at least 125 mm wide with a turned up or rounded leading edge.
- Effective mass of at least 365 kg for each square meter bottom face area.
- Positive control of vertical position, the angle of tilt, and the shape of the crown.
- Design together with appurtenant equipment such that positive machine screeding of the plastic concrete will be obtained as close as practical to the face of the existing curb line.
- Length sufficient to uniformly strike-off and consolidate the width of the lane to be paved.
- Forward and reverse motion under positive control.
- Supporting rails which are fully adjustable (not shimmed) to obtain the correct profile, unless otherwise approved by the Engineer. Provide supports which are sufficiently rigid that they do not deflect under the weight of the machine. Anchor the supporting rails to provide horizontal and vertical stability.
- Equipped to travel on the completed lane when placing concrete in a lane abutting a previously completed lane.

(d) Manufacturer's specifications and/or certification may be used as verification of the oscillating screed requirements.

(e) A drum roller equipped to perform all functions outlined for the oscillating screed above, may be used for finishing the overlay concrete in lieu of an oscillating screed. The drum roller must be equipped to vibrate by either a factory or field adaptation. The drum roller must be able to compact the concrete to at least 100 percent of the vibrated unit mass.

(4) Fogging equipment. Accomplish fogging by using high pressure equipment that generates at least 8.3 mPa at 8.3 L per minute, or with low pressure equipment having nozzles capable of supplying a maximum flow rate of 6.0 L per minute. In either case, the fog spray is produced from nozzles which atomize the droplets, and are capable of keeping a large surface area damp without depositing noticeable water. Use during placement and initial curing.

(5) General. Provide an overall combination of labor and equipment with the capability for proportioning, mixing, placing and finishing new concrete at the following minimum rates except when noted otherwise on the Plans:

TOTAL SURFACE AREA PER BRIDGE (m^2)	MINIMUM REQUIREMENT (m^3/hr.)
0-328	1.0
329-492	1.5
493-656	2.0
Over 656	2.5

(6) The elapsed time between depositing the concrete on the floor and final screeding may not exceed 10 minutes unless otherwise authorized by the Engineer.

b. Proportioning.

kg of Cement per Cubic Meter minimum	346
kg of Silica Fume per Cubic Meter, minimum	26
kg of water per kg of (Cement + Silica Fume), Max	0.37
Percent of Air by Volume	6.5±1.5**

** As Determined by KT-19 (Rollometer). A regularly calibrated air meter may be used for production with random verification by the rollometer. See note d, KT-19 for special requirements when using the rollometer with high cement concretes or mixtures with midrange water reducers or plasticizers.

(1) Use a ratio of the coarse aggregate to the fine aggregate of 50:50 by weight.

(2) Designate a target slump within the range of 50 to 125 mm.. A tolerance of 25% or 18 mm, whichever is larger, will apply to the target slump.

(3) A water-reducing admixture for improving workability may be required, and may be used when approved by the Engineer. Use admixtures in accordance with Section 402 and Special Provision 90M-130, latest revision. Adjust the designated slump accordingly.

(4) Adjust the yield cement factor (ycf) for higher air within specification limits, as allowed in the Standard Specifications.

(5) Delay the commencement of tests from 4 to 4½ min. after the sample has been taken from a continuous mixer. If a batch type mixer is used, take the tests at the point of placement and commence immediately.

c. Preparation of Surface.

(1) Old, Existing Concrete Decks. Prior to final preparation for placement of new concrete, make a complete cleanup by sand or shot blasting, followed by an air blast to remove all loose disintegrated concrete, dirt, oil, laitance, and curing material from patches and other foreign material from the surface of the prepared deck and bottom 75 mm of hubguard. Protect metal floor drains and areas of the curb or railing above the proposed surface from the sand or shot blast.

(2) New Concrete Decks. Prior to final preparation for placement of new concrete, sand or shot blast the surface followed by an air blast to remove all dirt, oil and other foreign material, as well as any unsound concrete, laitance, and curing material from the surface, the bottom 75 mm of hubguard, and edges against which new concrete is to be placed. Protect metal floor drains and areas of the curb or railing above the proposed surface from the sand or shot blast. It is

desired that the surface be roughened by the sand or shot blast to provide satisfactory bond with the surfacing concrete.

(3) Check the finish machine clearance above the prepared surface before concrete is placed to ensure the thickness is as specified on the Plans.

(4) Thoroughly wet any concrete surfaces to which the concrete is to bond with clean water for not less than two hours before the placing of the concrete overlay. Blow or broom away all free water immediately ahead of the placing operation. Bonding surfaces should be maintained in a damp condition with no free water.

d. Placing and Finishing Concrete.

(1) Environmental conditions during placement are critical to the quality of silica fume concrete. Of particular importance is the evaporation rate. Placing of silica fume concrete will not be allowed when conditions on the bridge deck are such that the evaporation rate (as determined in the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2) is estimated to equal or exceed 1 kg per square meter per hour, or is predicted to exceed that rate during the course of the placement. Prior to placing of concrete, temperature and humidity will be measured on the bridge deck, approximately 300 mm above the surface. Wind speed may be measured on the deck or estimated using information from the nearest weather station. Concrete temperatures may be those actually measured from the previous day's run, or from test batches, or may be estimated from aggregate, cement and water temperatures. With this information, use Figure 2.1.5 from the above reference (copy attached) to estimate the evaporation rate. When general area evaporation conditions are estimated to be above 1 kg per square meter per hour, the Contractor may proceed by using measures such as fogging, wind breaks, cooling the concrete, etc. to create **and maintain** environmental conditions (rate of evaporation less than 1 kg per square meter per hour) **on the bridge deck** which are satisfactory for silica fume concrete placement. The evaporation rate will be rechecked with the measures in place, using the procedures outlined above.

(2) A finishing machine meeting the requirements stipulated under equipment above will be required. Place and fasten the screed rails in position to insure finishing the concrete to the required profile. Place the supporting rails upon which the finishing machine travels outside the area to be concreted. A hold-down device shot into concrete will not be permitted unless the concrete is to be subsequently overlaid. Hold-down devices of other types leaving holes in exposed areas will be approved provided the holes remaining are grouted full. Methods for anchoring and supporting the rails and the concrete placing procedure require approval by the Engineer.

(3) Locate longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

(4)Produce and place the concrete within the specified limits in as continuous and uniform of an operation as practical.

(5) Manipulate, mechanically strike off, and mechanically consolidate new concrete to a minimum of 98 percent of the vibrated unit weight and screed to final grade. Hand tamping with a 150 mm x 150 mm metal plate device is required in irregular areas or along the curb where the finishing screed does not reach to assist in consolidation and bonding of the concrete. If concrete

for partial depth patches is placed with the overlay, apply additional vibration or hand tamping in the patch areas to ensure good bonding.

The Engineer will use an approved nuclear density measuring device to monitor in-place density. Hand floating operations may be required to produce a tight, uniform surface. Take every reasonable precaution to secure a smooth riding bridge deck. Correct surface variations exceeding 3 mm in 3 m unless directed otherwise by the Engineer.

(6) Silica Fume concrete is very prone to plastic shrinkage because it has no bleed water. To help reduce or eliminate shrinkage cracking, treatment with fogging equipment **and** precure material **are required** immediately after strike-off of the surface. If fogging has not been required during placement, start at this point and continue throughout the finishing operation. When the evaporation rate is above 1 kg per square meter fogging must be continuous. When the evaporation rate is below 0.5 kg per square meter a pattern of intermittent fogging should be used during the placing and finishing operation to maintain a visually damp surface on the concrete. Close observation of conditions and judgement should be used to maintain a damp surface on the concrete without flooding the surface with excessive water.

(7) When a tight, uniform surface has been achieved, give the surface a suitable texture by transverse grooving with a finned float having a single row of fins. Make the grooving approximately 5 mm in width, on 20 mm centers, with a groove depth of approximately 3 mm. Do this operation at such time and in such manner that the desired texture will be achieved while minimizing displacement of the larger aggregate particles. For bridges having drains, the transverse grooving should terminate approximately 600 mm in from the gutter line at the base of the curb. This area adjacent to the curbs should be given a light broom finish longitudinally.

(8) Finish the exposed edges of the end spans of bridges which form a part of the road surface with an edger having a 6 mm radius.

e. Curing.

(1) Apply Type 1-D liquid membrane forming curing compound **immediately** behind the tining float. The final cure will be with wet burlap covered with polyethylene sheeting.

(2) Continue fogging the entire placement to maintain a damp surface until the wet burlap can be applied.

(3) Place the burlap as soon as it can be without damaging the surface. Keep it wet 100 per cent of the time during the cure period. The use of soaker hoses or occasional spraying is required. Continue the wet burlap cure for a period of seven days.

(4) For the first twenty-four hours of the seven day curing period, when temperatures are predicted to remain above 15^{o}C, polyethylene sheeting may not be used in direct sunshine during the day when the concrete surface temperature is above 32^{o}C. However, it may be used at night in lieu of keeping personnel and equipment on the job site to keep the burlap wet. If polyethylene sheeting is used at night over the burlap during the first twenty-four hours when the concrete surface temperature is above 32^{o}C, it must not be placed prior to one hour before sunset, and must be removed within one hour after sunrise. After the first twenty-four hours, the polyethylene sheeting may be left in place continuously, day and night, for the remainder of the curing period.

At temperatures below 21^{o}C, black or clear polyethylene sheeting may be used. However, the concrete temperature must not be allowed to exceed 32^{o}C. If the concrete

temperature exceeds 32°C the polyethylene sheeting should be removed or replaced with white sheeting.

(5) Perform cold weather curing as outlined in the Standard Specifications.

(6) No traffic is permitted on a finished surface course for seven days after placement. At temperatures below 12°C, the Engineer may require a longer waiting time.

f. Weather Limitations.

(1) Concreting in Hot Weather. See Standard Specifications concerning hot weather concreting.

(2) Concreting in Cold Weather. Except by specific written authorization, discontinue concreting operations when a descending air temperature in the shade and away from artificial heat falls below 7°C. Do not start or resume operations until an ascending air temperature reaches 5°C, or if night time temperatures are expected to fall below 2°C.

g. Limitations of Operations.

(1)Provide a technical representative of the silica fume manufacturer on the job site during the initial placement of the concrete at no additional cost to the Department. The representative is to provide technical expertise to the Contractor, concrete producer, and the Engineer regarding batching, transport, placement, and curing of silica fume concrete. This requirement will be waived for experienced contractors. Submit your request along with a list of silica fume concrete overlay projects completed to the Engineer.

(2) At least 1 day prior to the placement, make a trial placement to gain experience with all aspects of this construction. This requirement may be waived by the Engineer if the Contractor and concrete producer can show significant similar experience with silica fume concrete.

(3) When a new deck is involved, do not commence work on the wearing surface until the lower course meets the time requirements of Section 701 of the Standard Specifications, unless specified otherwise.

(4) Do not place concrete adjacent to a surface course less than 36 hours old; however, this restriction does not apply to a continuation of placement in a lane or strip beyond a transverse joint in the same lane or strip.

(5) In areas where there is no traffic, preparation of the area may be started in a lane or strip adjacent to newly placed surface the day following its placement. If this work is started before the end of the seven day curing period, restrict the work as follows:

- Sawing or other operations may interfere with the curing process in the immediate work area for the minimum practical time only.
- Resume the curing promptly upon completion of the work.
- Keep the exposed areas damp until such time as curing media is replaced.
- Use no power driven tools heavier than a 7 kg chipping hammer.

h. Construction Joints. Make construction joints (either longitudinal or transverse) by placing and finishing the silica fume concrete approximately 150 mm beyond the desired location of the construction joint. After the silica fume overlay is cured, make a vertical saw cut at the location of the construction joint and chip away the excess silica overlay.

i. Sealing Vertical Faces of the Silica Fume Overlay. Seal all construction joints and vertical faces (such as the edge at the curb line) of the silica fume overlay. Sand or shot blast the construction joints and vertical faces, and then apply a concrete masonry coating to the cleaned vertical surfaces. Apply a concrete masonry coating that complies with the requirements of **Special Provision 90M-209** (latest revision).

j. Correction of Unbonded Areas. If newly overlain areas are discovered to be unbonded by tapping or chaining during construction of the project, outline the concrete from such areas by sawing, remove it with small air tools (7 kg maximum), and replace it at no additional compensation.

k. Material for Silica Fume Overlay.

(1) When approved by the District Engineer on repair of existing bridges, this pay item will be used to compensate the Contractor for the additional overlay material that will be required to fill the areas greater than the thickness of overlay shown on the Plans. The Contractor is responsible for maintaining adequate quality control of the demolition process to minimize deviations from the Plan grades.

(2) The Engineer will keep a running account of the volume of overlay material that is produced and delivered to the deck. When approved, the Contractor will be paid, at the set price per cubic yard, for all overlay material in excess of 110 percent of the theoretical volume to cover the deck area with the thickness of overlay shown on the Plans.

4.0 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.

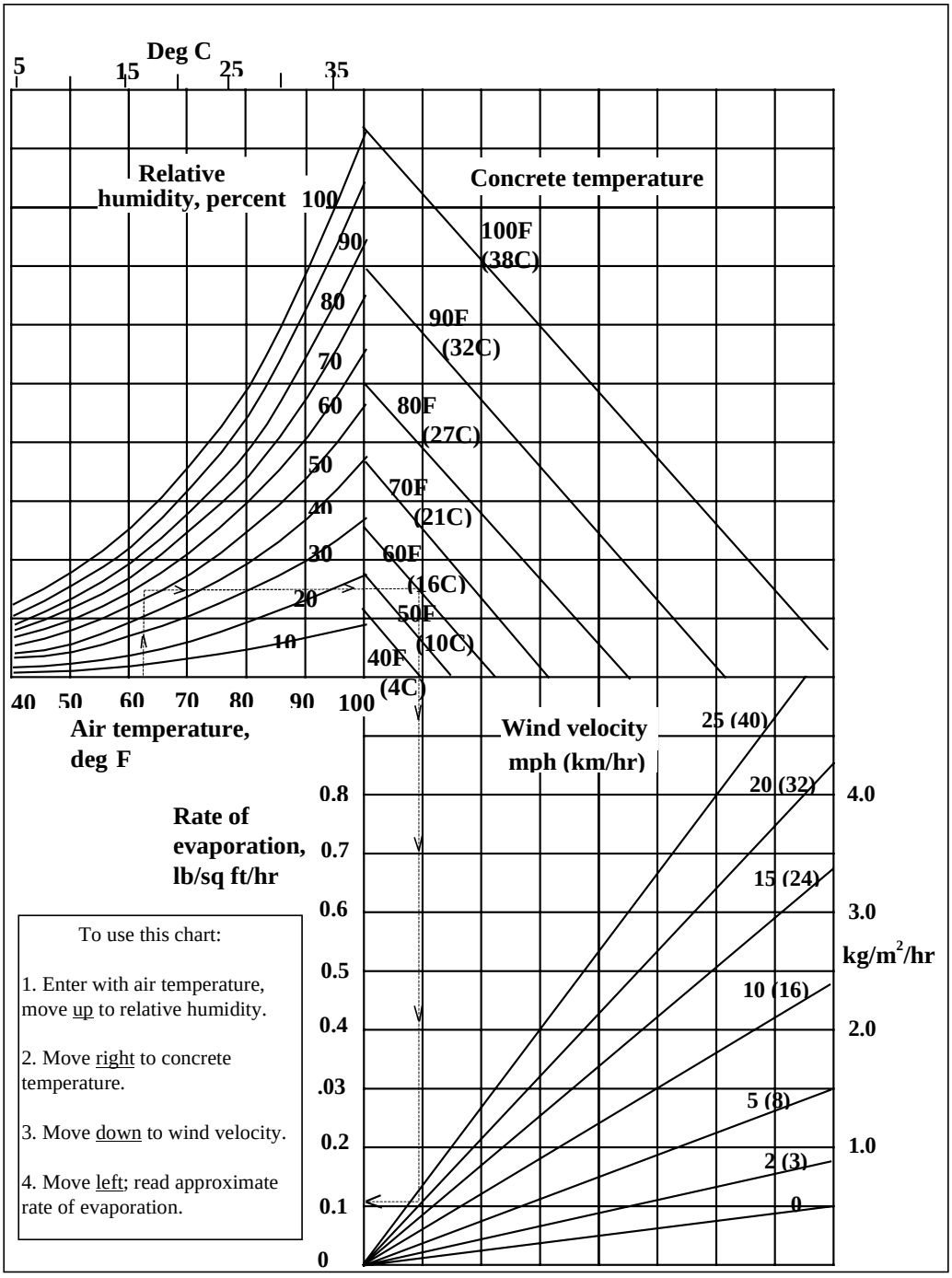
Silica Fume Overlay will be measured by the square meter, to the nearest 0.1 square meter, complete in place. Quantity for which payment will be made may be the quantities shown on the Plans provided the project is constructed as shown on the Plans. Material for Silica Fume Overlay will be measured by the cubic meter, to the nearest 0.1 cubic meter.

Payment for "Silica Fume Overlay" at the Contract unit price, and "Material for Silica Fume Overlay" at the Contract set unit price (when approved by the District Engineer), will be full compensation for the specified work.

11-30-00 M&R (DAM)

001050703	CA-7 CHAT	TONS	90M-158R*	PRQA
001050712	CA-7 CRUSHED GRAVEL	TONS	90M-158R*	PRQA
001050720	CA-7 CALCITE CEMENTED SS	TONS	90M-158R*	PRQA

STANDARD PRACTICE FOR CURING CONCRETE



Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. When the evaporation rate exceeds 0.2 lb/ft^2/hr (1.0 kg/ m^2/hr), measures shall be taken to prevent excessive moisture loss from the surface of unhardened concrete; when the rate exceeds 0.1 lb/ft^2/hr (0.5 kg/m^2/hr) such measures may be needed. When excessive moisture loss is not prevented, plastic cracking is likely to occur.

Create a new subsection in Section 1400, Concrete Admixtures and Curing Materials, titled Silica Fume.

SECTION 1400

SILICA FUME

1.0 DESCRIPTION.

This specification covers silica fume, or microsilica, which is suitable for use as an admixture for Portland cement concrete. Silica fume is a by-product resulting from the reduction of high-purity quartz with coal in electric arc furnaces in the manufacture of silicon and ferrosilicon alloys.

2.0 REQUIREMENTS.

Provide material that complies with the requirements of ASTM C 1240.

3.0 PREQUALIFICATION.

a. Sources of silica fume must be prequalified. Submit certified analyses of the quality control tests completed during the six month period immediately prior to the prequalification request. Certified analyses are defined as the range of test results of the properties specified above on representative materials tested by a laboratory which is regularly inspected and certified by the Cement and Concrete Reference Laboratory (CCRL). Include mill certifications for the raw material.

b. Forward the certified analyses to the Chief of Materials and Research. If the material satisfies all requirements, the source will be placed on a prequalified list.

c. Verification samples will be taken by each District at the rate of one per year for each silica fume producer supplying material to that District's projects.

d. Semi-annual results of the producers quality control testing as defined above, are required to be forwarded to the Bureau of Materials and Research to maintain status on the prequalified list. Sources will remain on the prequalified list so long as verification samples and semi-annual test results meet all requirements, and indicate acceptable quality control.

4.0 BASIS OF ACCEPTANCE.

a. Prequalification as required by **3.0** of this Special Provision.

b. A Type C certification in accordance with the Standard Specifications, Section 2600.

12-18-97 M&R (JLC)

042100000	Silica Fume	LBS	90M-158-R*	PRCT