Federal Highway Administration (FHWA)
Long-Term Bridge Performance (LTBP) Program

Selection Procedure for Reference and Cluster Bridges

For questions or comments contact:
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Long-Term Bridge Performance Program

U.S. Department of Transportation
Federal Highway Administration

Bridge Selection Approach - General Steps

1. Filter all bridges in the selected region using high level criteria
2. Obtain State prioritization for remaining population
3. Sort all remaining bridges into “Design of Experiments” subpopulations based on span length, age, and Average Daily truck Traffic (ADTT)
4. Compute the normalized distance measure for each bridge, which defines its experimental “power”
5. Rank the bridges within each subpopulation based on the distance measure
6. Select bridges from each subpopulation based on the distance measure and a set of supplemental criteria
7. Examine the distribution of secondary variables
8. Iterate until a balance between distance measure, supplemental criteria, and subpopulation variability is achieved

Bridge Selection Process

Step 1 Apply High-Level Filters

All candidate bridges adhere to the following criteria:

Bridge type (to be examined in the cluster being identified)
State owned and representative of bridge population
Service not over a railroad
Span length between 10 and 50 meters
Maximum number of lanes is 4
Maximum Average Daily Traffic (ADT) is 50,000
Bridge Age - built after 1960

These criteria were set to ensure that sampled bridges are similar to those likely to be constructed in the future, and to avoid excessive costs or access constraints.

Bridge Selection Process

Step 2 Obtain State Prioritization for Filtered Bridge Population

Bridges, which passed the high-level filtering, were submitted to the States within the region for informed prioritization according to the following categories:

Low - Data collection for this bridge is not feasible

Medium - Data collection for this bridge is feasible

High - Data collection for this bridge is a high priority*

*High priority indicates that the State expressed an interest in including the particular bridge in LTBP Cluster

Bridge Selection Process

Step 3 Sort Filtered bridges into "Design of Experiment" Subpopulations"

- Compute the median values of span length, ADTT and age for all remaining bridges
- Sort bridges into a full-factorial Design of Experiment based on whether their span length, ADTT, and age fall above (+) or below (-) the median:

Subpopulation	Span Length	ADTT	Bridge Age
A	+	+	+
B	+	+	-
C	+	-	-
D	+	-	+
E	-	+	+
F	-	+	-
G	-	-	+
H	-	-	-

Bridge Selection Process

Step 4 Compute the normalized distance measure for all remaining bridges

For each bridge, a distance measure was calculated according to the formula:

$$Distance\ Measure = \sqrt{\left(\frac{Age - Age_{Median}}{Age_{Median}}\right)^2 + \left(\frac{ADTT - ADTT_{Median}}{ADTT_{Median}}\right)^2 + \left(\frac{MSL - MSL_{Median}}{MSL_{Median}}\right)^2}$$

- This distance measure provides an indication of how "far" the bridge is from the median levels of span length (Mean Span Length – MSL), ADTT, and age for the bridge population
- Bridges with large distance measures to provide more information related to the influence of the primary parameters on bridge performance

Bridge Selection Process

Step 5 Rank the bridges within each subpopulation based on the distance measure

- Rank each subpopulation based on the distance measure
- Large distance measures are desirable for Cluster Bridges since they will allow the influence of primary variables on bridge performance to be uncoupled
- Small distance measures are desirable for Reference Bridges because they are representative of the most common or average bridges

Bridge Selection Process

Step 6a Select cluster bridges based on distance measure and supplemental criteria

Identification of a set of cluster bridges based on iteration of the following procedure:

1) Maximize the average distance measure of the set

2) Maximize the distribution of subpopulations (groups of span length, age, ADTT)

3) Maximize the distribution of State participation

4) Maximize the inclusion of “priority” bridges based on feedback from the States

Bridge Selection Process

Step 6b Select reference bridges based on distance measure and supplemental criteria

Identification of a pair of reference bridges based on the following procedure:

1) Minimize the average distance measure of the pair

2) Select candidates from *different* subpopulations

3) Select candidates from *different* States

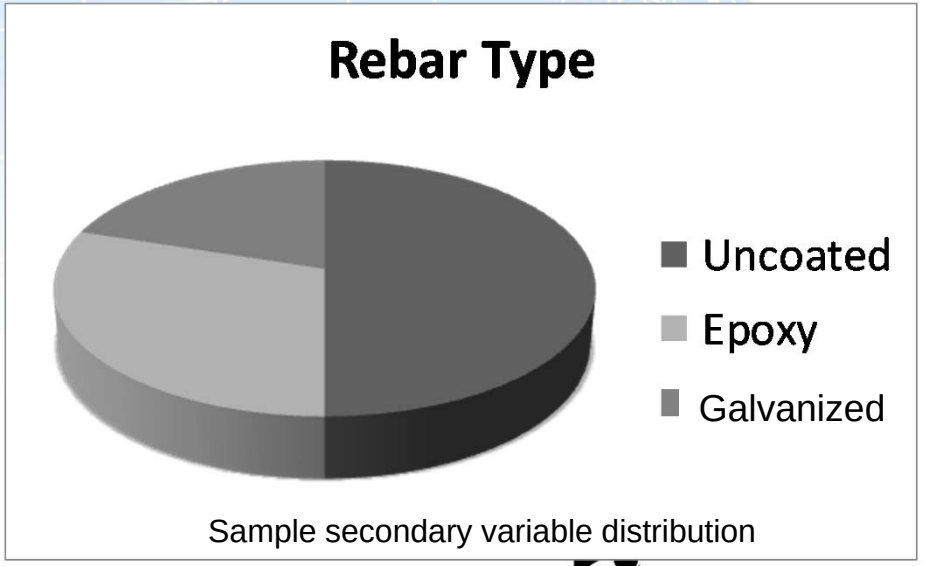
4) Minimize access constraints (i.e., low ADT, sizeable shoulders, etc.)

Bridge Selection Process

Step 7 Examine the distribution of secondary variables

Secondary variables were also selected in addition to age, ADTT, and span length to evaluate distribution of each in selection process:

- Structural form (continuous versus simple span)
- Rebar coating
- Skew angle
- Deck condition rating
- Superstructure rating
- Substructure rating



Sample secondary variable distribution

Bridge Selection Process

Step 8 Iterate through process until a balanced set of bridges is achieved and independently verify the selection

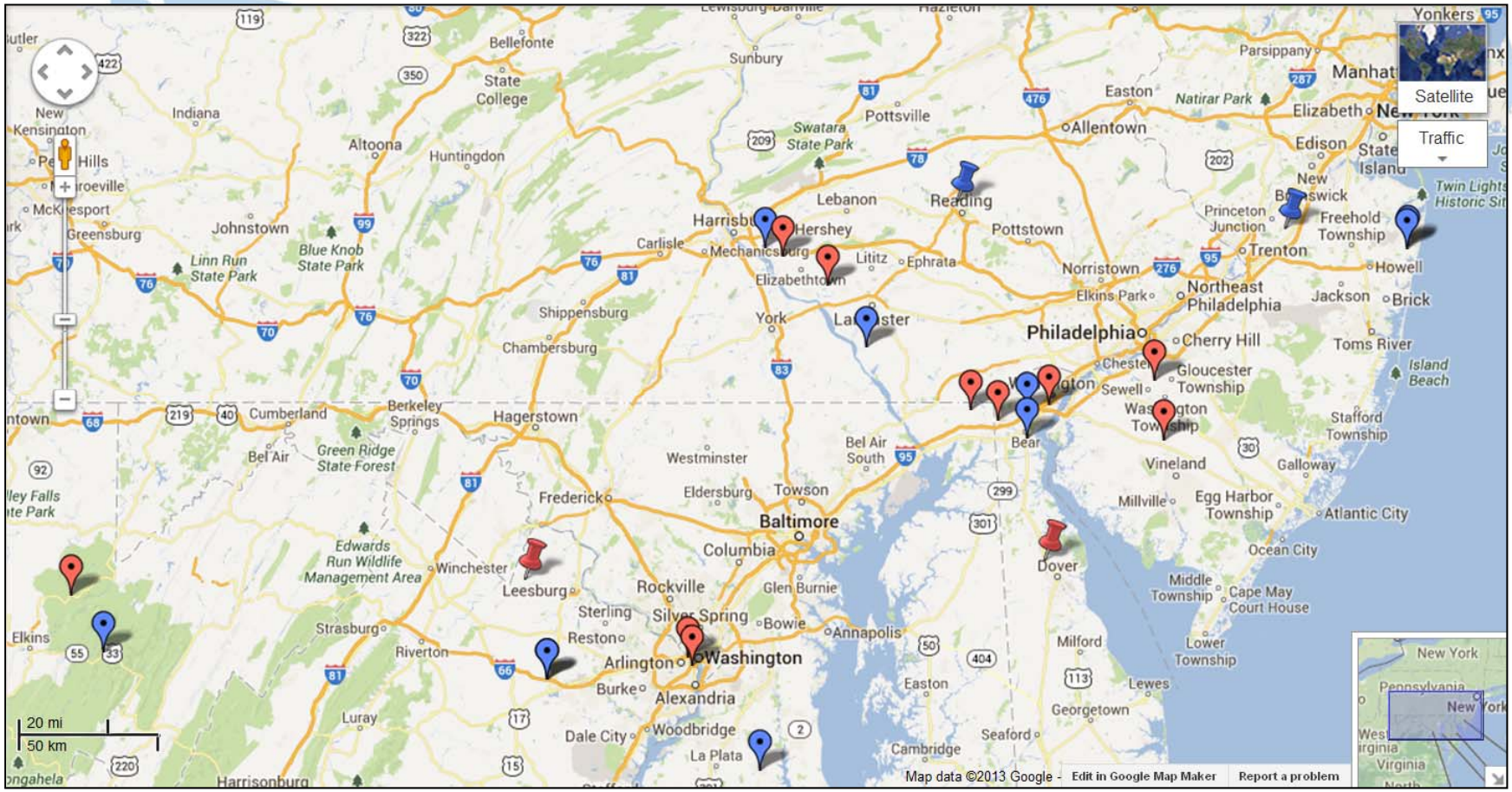
All reference and cluster bridges were remotely verified for testing suitability using the LTBP Bridge Portal, including:

- Primary and secondary criteria
- Location information
- Access constraints (independently via Google Maps)

All bridges will be verified via site visits prior to final approval

Bridge Selection Process

Resulting Mid Atlantic Steel and Prestressed Concrete Clusters – Bare Deck Subpopulation



Red Pin – Steel Reference
Red Marker – Steel Cluster

Blue Pin – Prestressed Concrete Reference
Blue Marker – Prestressed Concrete Cluster

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