# Development and Implementation of New York State's Comprehensive Bridge Safety Assurance Program

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Since 1990 the New York State Department of Transportation has been proactively involved in the planning, development, and implementation of its long-range comprehensive bridge safety assurance program. This program will be integrated into the department's bridge management system to provide important safety-based bridge information for capital and maintenance program planning. The development and implementation of procedures used to assess the vulnerability of existing bridges to six potential causes or modes of failure—hydraulic, structural steel detail deficiencies, collision, overload, structural concrete detail deficiencies, and earthquake—are discussed. Furthermore, the development and implementation of an overall bridge safety assurance policy aimed at the design and construction of new bridges, retrofitting bridges during their planned rehabilitation, and programming the remaining bridges for necessary actions to eliminate or reduce their vulnerability to catastrophic failure are also discussed.

During the past decade the New York State Department of Transportation (NYSDOT) has introduced several programs to ensure the structural integrity and safety of the bridge network in the state. In April 1987 the New York State Thruway Authority's bridge over Schoharie Creek collapsed during heavy floods, further underscoring the need for such programs. As a result the state's Highway Law was amended in 1989 to include the requirements for comprehensive bridge management and safety assurance programs and a uniform code of bridge inspection. Subsequently, the department began developing a systematic method to reduce the vulnerability of New York State's bridges to all potentially significant modes of failure. The planning aspects of this effort were previously reported by Shirolé and Holt (*1*).

In 1991 NYSDOT conducted an extensive survey of all states to determine the most common causes of bridge failure. A review of the 1,322 bridge failures reported revealed six failure modes as being the most significant in terms of the potential damage that they can cause to highway bridges in New York State. Three of these failure modes—hydraulic, overload, and collision—were found to be significant from the standpoint of frequency of incidence. Steel and concrete detail deficiency failure modes were considered significant in that they address potential vulnerability due to built-in design obsolescence in the existing bridge population. The earthquake failure mode was included in the program because of the severe consequences if even a single significant seismic event occurred in the Northeast. Based on significance and consequence, these failure modes are listed in prioritized order as follows:

1. Hydraulic,
2. Overload,
3. Structural steel detail deficiencies,
4. Collision,
5. Structural concrete detail deficiencies, and
6. Earthquake.

These failure modes are based on a nationwide survey of bridge failures since 1950 and were compiled by NYSDOT.

This paper discusses the development and implementation of procedures that can be used to assess and evaluate the extent of vulnerability of individual bridges to one or more of the identified failure modes. It presents an overview of the vulnerability assessment and evaluation procedures developed thus far for four of the six failure modes, and it discusses the development and implementation of an overall bridge safety assurance (BSA) policy aimed at the design and construction of new bridges, vulnerability retrofitting of bridges during their planned rehabilitation, and programming of the remaining bridges for necessary actions to eliminate or reduce their vulnerability to catastrophic failure.

## Vulnerability Assessment and Evaluation Procedures

### Conceptual Framework

The vulnerability of a structure to failure is a measure of its susceptibility to failure or collapse because of loads or environmental conditions not anticipated in the design. Failure, for the purpose of the BSA program, is defined as any physical change of a bridge that creates a threat to public safety or the complete loss of service. Failure could result from excessive displacement or distortion, structural instability, component collapse, and so forth.

To simplify the vulnerability assessment of New York State's large bridge population (Table 1) NYSDOT decided to use a multilevel process. Each level of this process successively refines the list of bridges so that those structures with greater vulnerabilities can be given a more detailed evaluation. This process comprises screening, classification, and rating steps that are intended to be performed sequentially and on a priority basis. Each step provides an increasing understanding of the specific vulnerability of a bridge. Bridges with greater vulnerabilities are first progressed through the various steps to focus the corrective actions on the most critical bridges in the shortest time. This results in a staggered progression of bridges through the assessment process.

**TABLE 1 Composition of New York State Bridges**

| Characteristic | Number of Bridges | | (a) + (b) | % of Total |
|---|---|---|---|---|
| | State (a) | Non-State (b) | | |
| Steel | 5386 | 8669 | 14055 | 72% |
| Concrete | 1699 | 1493 | 3192 | 16% |
| Prestressed Concrete | 586 | 926 | 1512 | 8% |
| Timber | 10 | 355 | 365 | 2% |
| All Other Types | 38 | 345 | 383 | 2% |
| Total | 7719 | 11788 | 19507 | 100% |

Completion of the vulnerability assessment process requires a review of construction plans, inspection reports, bridge files, and other related documentation. Site visits may also be necessary to confirm information and gather additional data.

The process begins by screening the entire bridge population to identify bridges that exhibit the characteristics relevant to individual failure modes and progresses through the classification of individual bridges into a high, medium, or low vulnerability class on the basis of their vulnerability relative to those of other bridges in that particular failure mode. The vulnerability rating is determined by using the results of the classification process and, when available, results of further analyses, for example, a hydraulic analysis combined with an evaluation of the consequences of a failure. The actual vulnerability rating is determined in a manner similar to that in the classification process, in that rating scores are assigned to evaluate the likelihood and the consequence of a failure and are then added together to determine the vulnerability ratings.

The rating step is common to all six identified BSA failure modes, and it is intended to provide a uniform measure of a structure's vulnerability to failure on the basis of the likelihood of a failure and the consequences should one occur. The likelihood of a failure event is a measure of the probability of an external load condition exceeding the structural capacity, whereas the consequence of a failure refers to the impact of a bridge failure in terms of loss of life, injury, traffic disruption, or economic loss. There are six possible ratings, from 1 to 6. These ratings indicate what type of corrective action is needed to reduce or eliminate vulnerability to failure and the urgency with which this action should be implemented. On the basis of the vulnerability rating, an interim action such as load posting or bridge closing may be necessary until a detailed evaluation can be completed and more permanent vulnerability reduction measures taken. The following are the six possible ratings:

1. Safety priority action. This rating designates a vulnerability to failure resulting from loads or events

that are likely to occur. Remedial work to reduce the vulnerability must be given immediate priority.

2. Safety program action. This rating designates a vulnerability to failure resulting from loads or events that may occur. Remedial work to reduce the vulnerability does not need immediate priority, but waiting for capital program action would be too long.

3. Capital program action. This rating designates a vulnerability to failure resulting from extreme loads or events that are possible but not likely. This risk can be tolerated until a normal capital construction project can be implemented.

4. Inspection program action. This rating designates a vulnerability to failure presenting minimal risk, provided that anticipated conditions or loads on the structure do not change. Unexpected failure can be avoided during the remaining life of the structure by performing special inspections.

5. No action. This rating designates a vulnerability to failure that is less than or equal to the current design standards. The likelihood of failure is remote.

6. Not applicable. This rating designates that there is no exposure to a specific type of vulnerability.

Figure 1 shows a typical six-digit vulnerability rating code for a bridge developed to assist in prioritizing BSA actions. Each digit in the six-digit code reflects the vulnerability rating for a specific failure mode. By this coding system, all bridges that have a rating of 1 in any failure mode will take precedence in maintenance, repair, or replacement decisions. The presence of an individual bridge on the vulnerability list is thus determined by having at least one rating of 1 within its rating number and is further prioritized by the position of any 1 (starting from the left) in the vulnerability rating code.

Results from the rating steps for each vulnerability mode provide input to the overall structural integrity evaluation (SIE), which is a detailed engineering evaluation covering all aspects of a bridge's structural condition and integrity as well as present and future needs for preserving or upgrading the safety and serviceability

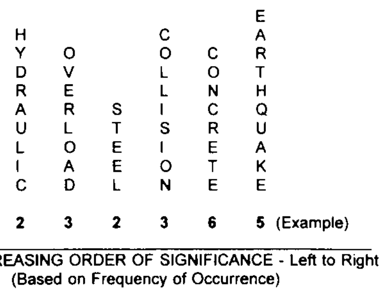


**FIGURE 1 Bridge vulnerability rating code.**

of the bridge. This evaluation covers all identified vulnerability factors and failure modes and is expected to be done for bridges with a vulnerability rating of 1, 2, or 3.

Vulnerability assessment and evaluation procedures have been under development and follow this conceptual framework. Procedures for determining hydraulic, structural steel detail deficiency, overload, and collision vulnerabilities to failure have been developed and are in various stages of implementation. An overview of these procedures is presented herein specifically for each failure mode. Since the rating step is common to all modes, discussion of the rating step is presented in its entirety only in the section on hydraulic vulnerability procedures and is not repeated in the sections on the other procedural discussions.

## Hydraulic Vulnerability

The goal of the hydraulic vulnerability assessment is to identify bridges prone to failure due to scour or related hydraulic forces and, if necessary, to initiate measures such as NYSDOT's Floodwatch and Post-Flood Inspection Programs, interim retrofits, and capital improvements to reduce hydraulic failure vulnerability. This is accomplished through a series of assessment steps that result in a hydraulic vulnerability rating for each structure.

Figure 2 provides an overview flow chart of hydraulic vulnerability assessment procedures. A detailed discussion of this procedure has been presented previously by Shirolé and Loftus (2) and is summarized here.

### *Screening*

The hydraulic vulnerability assessment process begins with the inventory screen. This screen uses information contained in the department's Bridge Inventory and Inspection System (BIIS) data file to identify structures that do not span water (summarized in Table 2). These structures are assigned a vulnerability rating of 6 (not applicable) and are eliminated from the assessment process. The remaining bridges are subjected to a two-part susceptibility screening that consists of a review of bridge plans, construction documents, inspection reports, and other available information to place bridges in four susceptibility groups, numbered groups 1 through 4. The susceptibility groups are used to indicate a bridge's relative susceptibility to damage from hydraulic forces and to determine the order in which they progress to the classification step. Figure 2 contains a tabulated list of factors that are used in the first part of the susceptibility screen to identify structures with low susceptibilities to scour damage. Those structures are

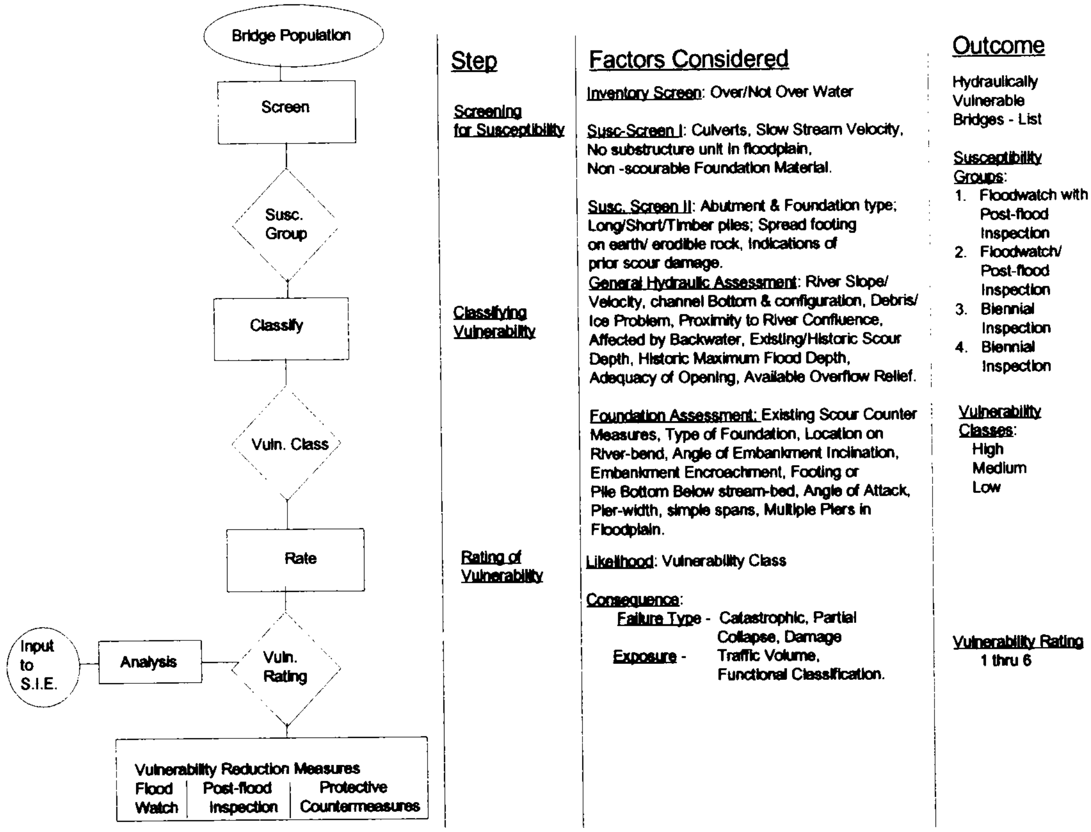


FIGURE 2 Hydraulic vulnerability assessment.

placed in susceptibility group 3 or 4. The second part of the susceptibility screening places bridges in the first, second, or third susceptibility group on the basis of their substructure configurations and assessment of scour conditions by considering factors listed in tabulated form in Figure 2.

## *Classification*

The second step in the hydraulic vulnerability assessment process is to evaluate a structure's vulnerability to scour damage on the basis of its site hydrology and hydraulic characteristics. This classification step consists of general hydraulic and foundation assessment procedures. The considerations on which these procedures are based are listed in tabulated form in Figure 2. This step quantifies the potential vulnerability of a structure to hydraulic damage relative to the vulnerabilities of other bridges in the classification process and places the structure in a high, medium, or low hydraulic vulnerability class. These classes indicate the likelihood of failure and are used to determine the vulnerability rating for a structure and also whether a structure should be placed on a floodwatch list or a postflood inspection list (*3*). NYSDOT's Floodwatch Program is intended to ensure that bridges with a high susceptibility to damage or failure from hydraulic forces are monitored during periods of flooding, as long as the bridge remains vulnerable. The Post-Flood Inspection Program monitors the performance of hydraulically vulnerable bridges following a major flood event.

## *Rating*

The hydraulic vulnerability rating is determined by using the results of the classification process, combined with an evaluation of the consequences of a failure. The actual vulnerability rating is determined in a manner similar to that in the classification process, in that rating

TABLE 2 New York State Bridges over Water

| Characteristic | Number of Bridges | | (a)+(b) | % of Total |
|---|---|---|---|---|
| | State (a) | Non-State (b) | | |
| Non-Navigable | 3407 | 8054 | 11461 | 59% |
| Navigable | 58 | 127 | 185 | 1% |
| NYS Canal | 224 | 107 | 331 | 2% |
| Unknown | 300 | 177 | 477 | 2% |
| Total | 3989 | 8465 | 12454 | 64% |

scores are assigned to evaluate the likelihood and the consequence of a failure and are added together to determine the hydraulic vulnerability rating.

### *Evaluation*

A detailed hydraulic analysis of vulnerable bridges is conducted on a prioritized basis to provide a quantitative assessment of the performance of an existing bridge in comparison with current hydraulic design requirements. The results of this analysis are then used in an SIE to determine the stability of a bridge against hydraulic forces. The analysis is also necessary to design hydraulic improvements and scour protection countermeasures at a bridge, and the results can supplement and refine the data used in the classification and rating procedures. The most commonly used hydraulic vulnerability reduction measures are riprap, stone fill, and gabions installed at a pier or abutment. Some of the other available methods include constructing guide banks and dikes to protect abutments, improving the channel to lessen the potential for the occurrence of scour, installing sills or drop structures to stabilize the channel, and strengthening the existing foundations or increasing the bridge opening to lessen the vulnerability of the structure.

## Steel Detail Deficiency Vulnerability

The goal of the steel detail deficiency vulnerability assessment is to identify bridges prone to failure due to steel detail deficiencies or deterioration and, if necessary, to initiate measures to reduce failure vulnerability. This is accomplished through a series of assessment steps that result in a steel detail deficiency vulnerability rating for a structure. Figure 3 provides an overview flow chart of the steel detail deficiency vulnerability assessment procedures.

### *Screening*

The screening step consists of an inventory screen and a more refined bridge-type screen. The inventory screen is a preliminary screening procedure that identifies nonmetal, closed, and abandoned bridges and structures that do not carry truck traffic, such as parkway and pedestrian bridges, through a review of information

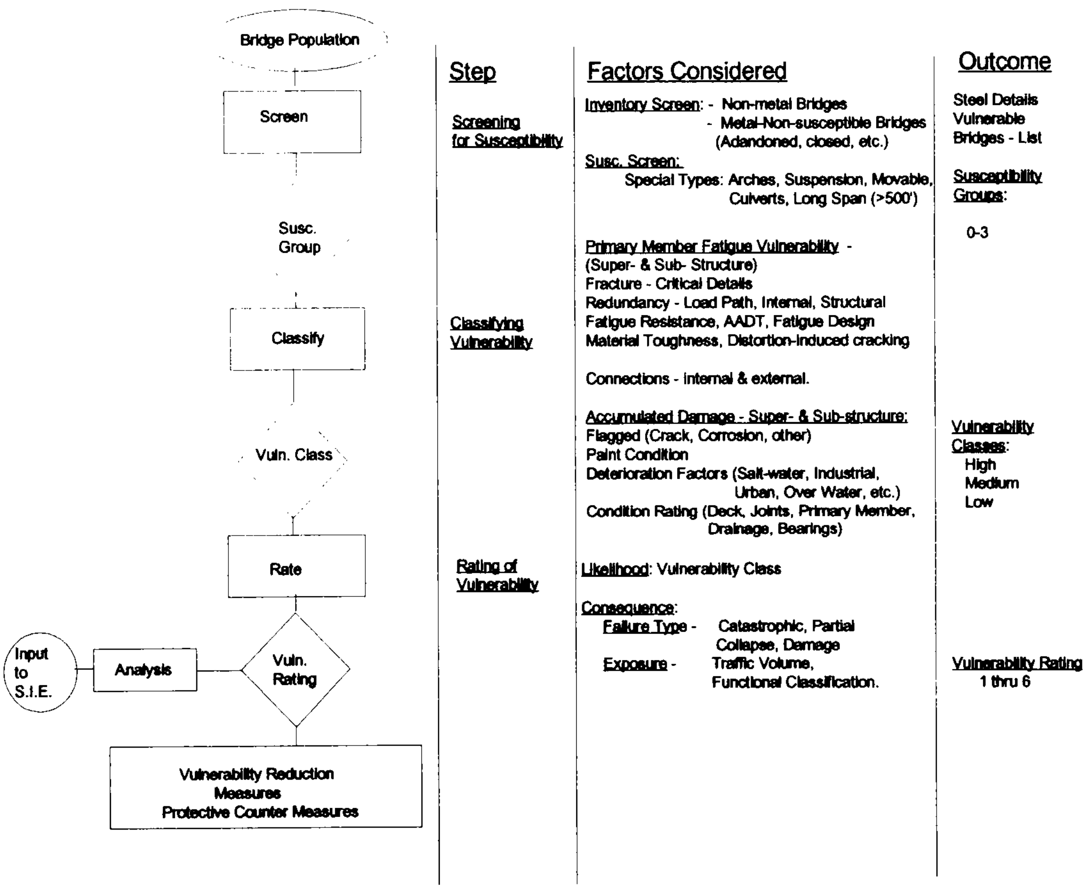


FIGURE 3 Steel detail vulnerability assessment.

contained in the BIIS data files and the Superstructure Code Database. These structures are assigned a vulnerability rating of 6 (not applicable). No further actions are required for these structures.

The first stage of the bridge-type screen is to segregate special types of bridges that are not easily analyzed through the standardized vulnerability assessment procedure. These bridges, which are evaluated directly through an SIE, include all culverts, arches, tied arches, suspension bridges, moveable bridges, steel plate pipes, pipe arches, railroad bridges, and long-span (>500-ft) bridges. The second stage sorts each of the remaining bridges into one of three susceptibility groups on the basis of their respective superstructure types. These groups imply a relative susceptibility to failure due to fatigue, deterioration, or other steel detail-related causes and are used to determine the order in which bridges progress to the classification step. At the completion of the bridge-type screen, bridges in susceptibility group 1 are progressed to the classification step first; this is followed by groups 2 and 3, respectively.

### *Classification*

The classification step evaluates the vulnerability of a structure to failure on the basis of its structural steel details, as well as its traffic, design, deterioration, and environmental conditions. This step quantifies the potential vulnerability of a structure to steel detail deficiency failure relative to that of other bridges in the classification process and places the structure in a high, medium, or low vulnerability class. The vulnerability classes describe the relative potential that a structure has for failure because of steel detail-related problems. These classes are used to determine the vulnerability rating of a structure.

A field evaluation by a trained engineer may be necessary to complete the vulnerability classification step for some bridges. During the field inspections the evaluating engineer is required to look for catastrophic failure-prone conditions that could lead to a sudden collapse of the structure. If any potentially catastrophic conditions are observed, then appropriate interim vulnerability reduction measures are to be recommended to safeguard the bridge against a failure until a more detailed evaluation and remediation plan can be developed.

Figure 3 indicates in a tabulated form the criteria used in the classification step. They include consideration of primary member fatigue vulnerability for both super- and substructures, the vulnerabilities of connections, and accumulated super- and substructure damage. The score from the classification step is used to place a bridge in its appropriate vulnerability class.

### *Rating*

The steel detail deficiency vulnerability rating is determined by the procedures described in the hydraulic vulnerability discussion.

### *Evaluation*

Structures with a vulnerability rating of 1 or 2 are immediately considered for retrofit work as a vulnerability reduction measure. If the decision to retrofit the structure is made, the work is programmed, and when the retrofit work is completed, the structure is given a new rating taking into consideration the work that was done. Structures with a vulnerability rating of 3 that are included in the capital improvement program are evaluated during their design phase. If the decision is not to retrofit, the vulnerability ratings for the other five failure modes are also considered. On the basis of all of these ratings, a priority list is established and SIEs are performed in this priority order.

## Overload Vulnerability

The goal of the overload vulnerability program is to identify the relative vulnerability of the state's bridges to failure due to overload so that necessary vulnerability reduction measures can be implemented in an efficient and effective manner. Figure 4 presents an overview flow chart of the overload vulnerability assessment process.

### *Screening*

The screening process begins with an inventory screen of the BIIS data file to identify highway bridges. These bridges progress to the classification step. Non-highway bridges and culverts are assigned a vulnerability rating of 6 (not applicable) and are eliminated from the assessment process.

### *Classification*

The classification step begins with a preliminary classification stage that consists of load expectancy and structural capacity assessments. The factors considered at this stage are listed in tabulated form in Figure 4. The assessments use bridge inventory information on bridge load types as well as structural strength and condition to assess the vulnerability to overload failure and result in a preliminary classification score. Local conditions such as load restrictions on bridge approaches, heavy truck traffic, level of truck weight limit enforcement, and physical site restrictions for trucks entering

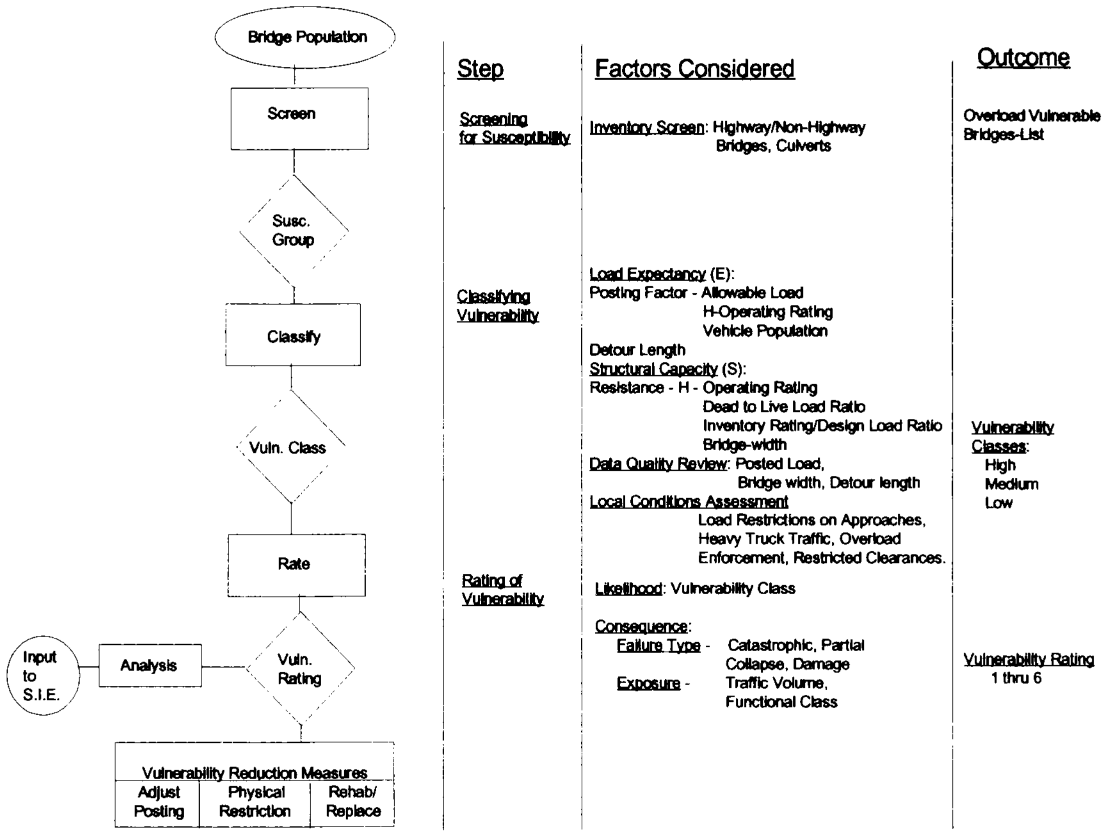


**FIGURE 4** Overload vulnerability assessment.

a bridge are also considered. On the basis of this information the preliminary classification scores are then adjusted as necessary to arrive at a final vulnerability classification score. This classification score quantifies the structure's overload vulnerability relative to those of other bridges in the classification process and places the structure in a high, medium, or low vulnerability class. The vulnerability class describes the relative potential that a structure has for failure due to overloads and is used in determining the vulnerability rating.

### *Rating*

The overload vulnerability rating is determined by the procedures described in the hydraulic vulnerability discussion.

### *Evaluation*

The evaluation step provides a quantitative engineering analysis of a bridge's vulnerability to overload failure in comparison with current design standards. It is conducted immediately for structures with a vulnerability rating of 1 or 2. Structures with a vulnerability rating of 3 that are included in the capital improvement program are evaluated during their design phase. The results of this evaluation are used in conjunction with evaluations for other failure modes to compile an SIE report for a bridge and to develop any required vulnerability reduction measures.

An evaluation of overload vulnerability will typically consist of a load rating analysis to determine the load-carrying capacity of a structure and also to provide information for use in the development of retrofit plans. In some cases a physical load test may also be necessary or useful. Typical overload vulnerability reduction measures consist of load posting, closing, rehabilitation or replacement.

## Collision Vulnerability

The goal of the collision vulnerability assessment procedure is to identify the relative vulnerability of the state's bridges to failure due to vehicle, vessel, or train collision impact damage so that any necessary vulnerability reduction measures can be implemented in an efficient and effective manner. Figure 5 presents an overview flow chart of the collision vulnerability assessment process.

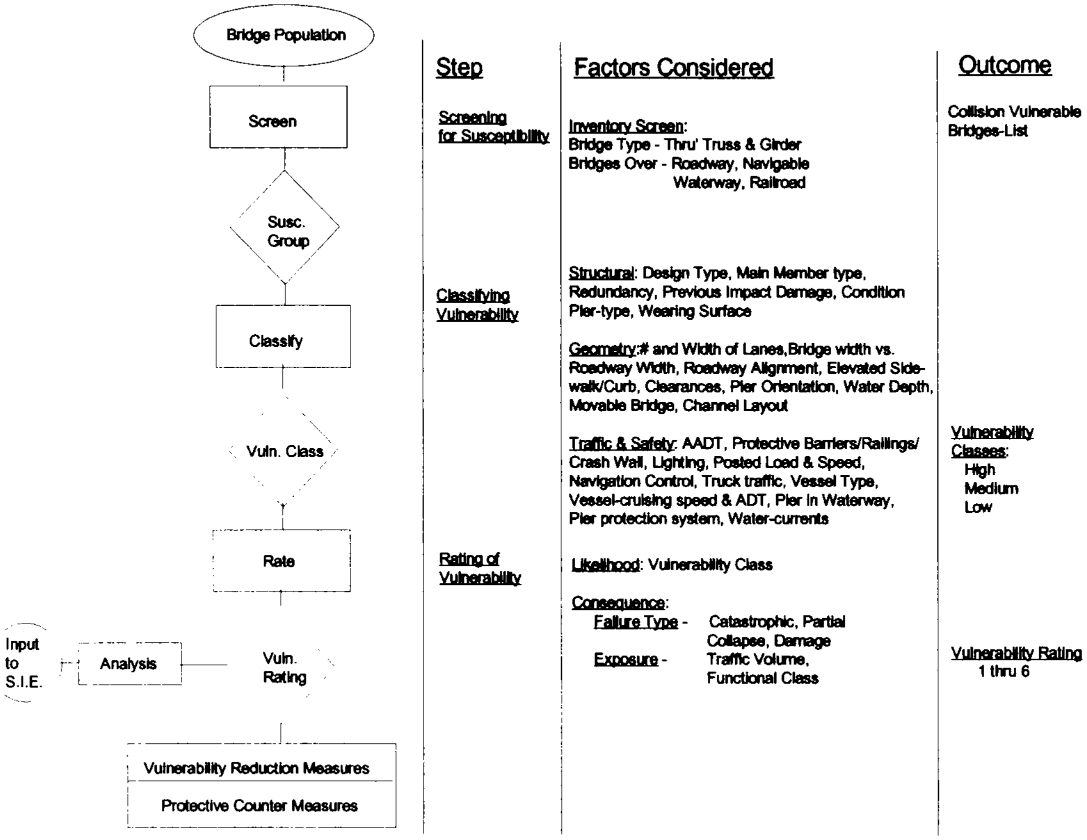


FIGURE 5 Collision vulnerability assessment.

### *Screening*

The collision vulnerability assessment process begins with an inventory screen of the BIIS data file to identify bridges vulnerable to collisions on the basis of their structure type (e.g., thru truss/girder) and whether they span a roadway, navigable waterway, or railroad. Structures that do not meet the screening parameters are assigned a vulnerability rating of 6 (not applicable) and are eliminated from the assessment process.

### *Classification*

The classification step uses information (tabulated in Figure 5) such as impact factors, exposure factors, characteristics of traffic, and the geometrics of the structure and its approaches to evaluate the vulnerability to collision impact damage or collapse. The product of this step is a vulnerability classification score and an assignment to a high, medium, or low vulnerability class. The vulnerability classes describe the relative potential that a structure has for failure due to collision impact damage, and it is used in the rating step to determine the vulnerability rating for a structure.

### *Rating*

The collision vulnerability rating is determined by the procedures described in the hydraulic vulnerability discussion.

### *Evaluation*

The evaluation step provides a quantitative engineering assessment of a bridge's vulnerability to collision impact damage or collapse. The results of this evaluation are used, in conjunction with evaluations for other failure modes, to compile an SIE report for a bridge and to develop any required vulnerability reduction measures. Typical vulnerability reduction measures consist of installing or constructing protective features or developing rehabilitation or replacement plans for the structure. A typical collision vulnerability protection measure for a "thru" type of structure would be installation, or upgrade, of a bridge railing or barrier system that is sufficient to mitigate an impact. Other possible vulnerability reduction measures may include rehabilitation or removal of previous impact damage.

### Status of Implementation

The development of the assessment and evaluation procedures has been performed in a sequential manner, and extensive training and implementation activities have followed the completion of development activities for each failure mode. The training activities have entailed the development of new training materials and organization of available training materials with hands-on training exercises in the use of assessment and evaluation procedures for each type of vulnerability. Table 3 summarizes the implementation status of the assessment and evaluation procedures for each of the six failure modes.

## NYSDOT'S COMPREHENSIVE BSA POLICY

Since 1990 the NYSDOT BSA activities have progressed systematically through the development of vulnerability assessment and evaluation procedures, specialized training in their application, and implementation of vulnerability reduction measures deemed necessary as the process was being implemented. The knowledge and experience gained through these activities enabled the department to develop its comprehensive BSA policy (*4*). Adopted in 1992, this policy clearly outlines the department's commitment to ensuring public safety and minimizing adverse economic impacts due to the loss of service of the state's bridge network. It states NYSDOT's objective to implement a proactive system to assess and evaluate all state-owned bridges for their failure vulnerabilities and outlines a specific policy and plan of action for each failure mode organized in a prioritized manner.

**TABLE 3 Status of Implementation**

| FAILURE MODE | STATUS |
|---|---|
| HYDRAULIC | Assessment Procedures Manual developed and promulgated<br>State-owned Bridges:<br>Assessments 96% (3761) completed<br>Over 300 evaluated through hydraulic analysis & scour calculation, Over 500 have vulnerability reduction projects either in progress or completed.<br>551 are on Floodwatch to ensure public safety during flood events, and 877 are on Post-flood Inspection Program.<br>Locally owned Bridges:<br>Assessments for 7973 bridges started in 1995. Results to be forwarded to owners. During past two years, computer inventory screen lists were provided to local bridge owners, with recommendations for a floodwatch program for certain bridges. |
| STEEL DETAILS | Assessment Procedures Manual developed and promulgated<br>State-owned Bridges:<br>Assessments 56% (3107) completed<br>Prior Programs: Pin and Hanger - 21 bridges evaluated and retrofits completed<br>2 and 3 Welded Girder - 108 bridges evaluated and retrofits completed<br>Vulnerability reduction projects for 75 bridges. |
| OVERLOAD | Assessment Procedures Manual developed and promulgated<br>State-owned Bridges:<br>Assessments 25% (1882) completed<br>Currently 96 bridges load-posted<br>Locally-owned Bridges:<br>Computer Inventory Screen list to be sent to local bridge owners in 1995 |
| COLLISION | Assessment Procedures Manual developed and promulgated |
| CONCRETE DETAILS | Assessment Procedures development scheduled to be completed in 1995 |
| EARTHQUAKE | Interim Assessment procedures and policies promulgated<br>Final Assessment procedures scheduled for completion in 1995 |

The specific plan of action for each failure mode consists of the following:

- Development of vulnerability assessment procedures. Each type of failure is to be analyzed and an assessment procedure is to be developed to rate each bridge on the basis of the contributing vulnerability factors. The vulnerability rating system will ensure that bridges are rated on a uniform scale for the respective factors and will be compatible with the comprehensive bridge management system being developed by the department.

Each failure mode will require an individual assessment procedure that will be very technical in nature and that will require specialized training in some instances. Owing to the variety of field conditions, this process will require enough flexibility to allow for engineering judgment at all stages of the assessment. This procedure is merely a tool for the engineer to use in making comparative assessments of a large population of bridges.

- Vulnerability assessment of existing bridges. All state bridges shall be assessed for each of the six failure vulnerabilities described in this paper and shall be rated from 1 to 6 for each failure mode, consistent with the likelihood and consequence of failure of each bridge. Structures rated 1, 2, or 3 shall be programmed for appropriate action, whereas those rated 4 shall be scheduled for special monitoring inspections to preclude unexpected failures. The vulnerability ratings will be used to prioritize bridges for an SIE that will provide documentation for any vulnerability reduction action considered.
- Programmed vulnerability reduction actions. Structures scheduled for replacement are to be designed according to the current AASHTO standard specifications for highway bridges, as modified/supplemented by appropriate NYSDOT bridge design and construction standards and specifications. Special attention shall be given to site-specific considerations to ensure that the replacement structure is not vulnerable to failure modes. Structures scheduled for rehabilitation shall be designed and detailed to significantly reduce or elimi-

nate their vulnerabilities to failure modes by incorporating vulnerability reduction measures in the rehabilitation plans.

The BSA program shall be an ongoing and proactive approach aimed toward the assessment, evaluation, and mitigation of the failure vulnerability of New York State bridges.

This policy shall apply only to NYSDOT-owned bridges. However, the department will provide information on its BSA policies and practices to other bridge-owning governmental agencies in the state and encourage their implementation.

## Conclusion

NYSDOT's comprehensive BSA program has successfully progressed from its planning phase to development and implementation phases. Six modes of failure—hydraulic, overload, structural steel detail deficiencies, collision, structural concrete detail deficiencies, and earthquake—were identified as significant after a nationwide survey of bridge failures. The vulnerability assessment procedures for the first four modes of failure have been developed; this has been followed by intensive training in the use of those procedures, guidance and monitoring of their actual application, and the use of vulnerability reduction measures that have been implemented or that are under way. NYSDOT's comprehensive BSA policy, developed through the knowledge and experience it gained through the development process and subsequently adopted in 1992, clearly outlines New York State's approach and commitment to ensuring the safety of its extensive bridge network.

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