Safe and Sustainable Temporary Construction Barriers

Requested by
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Executive Summary

Background

The California Department of Transportation (Caltrans) is adopting the recommendation put forth by the American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) to apply the Manual for Assessing Safety Hardware (MASH) when evaluating temporary construction barriers. To date, Caltrans has selected concrete temporary construction barriers, but the new requirement to adopt MASH-compliant barriers gives Caltrans the opportunity to consider all options now available—steel, concrete and various combinations of materials and shapes.

Caltrans is seeking information about the features, functionality, benefits and challenges of each temporary construction barrier product and a limited environmental assessment to facilitate its examination of temporary construction barrier alternatives.

To assist Caltrans in this information-gathering effort, CTC & Associates surveyed state departments of transportation (DOTs) to learn more about agency practices and policies regarding temporary construction barriers. A second survey of selected vendors offering temporary construction barrier products gathered details of these vendor products. Supplementing survey findings is an examination of information available from two pooled fund studies, including research conducted by the Midwest Roadside Safety Facility and MASH compliance data provided by Roadside Safety Pooled Fund. Also included are selected publications identified in the course of completing this investigation and publications provided by survey respondents.

Summary of Findings

This Preliminary Investigation gathered information in four areas:

- Survey of state practice.
- Survey of barrier vendors.
- MASH-compliant portable barriers.
- Related research and resources.

Survey of State Practice

An online survey distributed to state DOTs gathered information about the temporary construction barriers used by these agencies. Ten transportation agencies responded. Table ES1 identifies the barrier systems described in detail by nine of the 10 respondents. Five of the nine agencies use at least one MASH-compliant temporary construction barrier constructed of concrete.

Table ES1. Temporary Construction Barrier Systems

State	MASH Compliant	System Name/Vendor	Material
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete

State	MASH Compliant	System Name/Vendor	Material
Arkansas	No	Concrete barrier wall (New Jersey shape) Vendor not specified	Concrete
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors	Concrete
Indiana	Yes	Road Zipper system Lindsay Transportation Solutions	Concrete
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete
Minnesota	Yes	18” Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel
New Mexico	Yes	Unspecified concrete barrier Vendor not specified	Concrete
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, Test Level 3 (TL-3)) Nonproprietary system	Combination of steel and concrete
Tennessee	No	Portable concrete barrier Vendor not specified	Concrete
Tennessee	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified
Wisconsin	Pending	Concrete barrier temporary precast 12’ 6” Vendor not specified	Concrete

The 10th respondent, from Missouri DOT, noted that his agency does not choose barrier systems but allows different barrier types as long as the barrier meets NCHRP Report 350 or MASH testing requirements. The respondent also noted that “[p]redominately, the industry uses concrete barriers, but lately we have seen steel barrier systems on projects.”

Agency Policies for Temporary Construction Barrier Selection

Seven responding agencies reported on policies or practices to use concrete temporary construction barriers (Arizona, Arkansas, Indiana, Minnesota, New Mexico, North Carolina and Wisconsin).

In Indiana, system selection is guided by the agency's Standard Specifications, which indicate that the Type 2 barriers used to separate traffic from a work zone can be either concrete or steel provided the barrier is crashworthy and its deflection is appropriate; similar requirements apply to Type 4 barriers (movable wall). Indiana DOT has used an unspecified temporary concrete barrier on "numerous" projects; the respondent did not describe a steel barrier used by the agency. New Mexico uses contractor-provided concrete barriers for the majority of installations, specifying that the barriers must be "in good shape or new."

Minnesota DOT designers may choose steel barriers for projects when the added weight of a barrier is a concern (for example, on a bridge deck). Steel barriers are used in New Mexico when there is a restriction for weight of the barrier. While steel products are included in North Carolina DOT's approved products list, contractors do not regularly use them. Pennsylvania DOT's temporary construction barrier of choice is a combination of steel and concrete that has been used in thousands of applications.

Impact of Climate on Barrier Selection

When asked to describe how climate and climate zones affect their agencies' selection of temporary construction barriers, only two respondents reported on climate impacts:

- In Pennsylvania, all barriers must be slotted to allow for water drainage during inclement weather for projects that remain active or where temporary traffic patterns are present during the winter months.
- Wisconsin DOT does not allow water-filled barriers of any type.

Description of Temporary Construction Barrier Systems

A series of six tables beginning on page 16 provides details of the temporary construction barriers respondents described in their survey responses. Highlights from each table appear below.

General description (see page 16). This table identifies the barrier systems as pinned or free-standing and describes the frequency of use. The type of system used most frequently by respondents is a free-standing concrete barrier. Several respondents using this type of system use it for almost all projects, favoring a concrete system over steel if both are permitted for use by an agency.

System composition (see page 18). In this table, the length, width and weight of each "stick" of a barrier system is described, as is the maximum dynamic deflection distance.

- Stick lengths ranged from 1 to 2 feet to 30 feet. The most typical length is from 10 to 20 feet.
- Stick widths are sometimes given for the top and bottom of a barrier; in these cases, bases range from 1 to 2 feet. The most frequently cited single dimension is 2 feet.
- Stick weight ranged from 1,500 pounds to 3.9 tons.

- Maximum dynamic deflection distance also ranged widely, from less than 1 foot to 14 feet for North Carolina's water-filled barrier.

Loading and transport (see page 20). Respondents described the equipment needed to load and unload barrier systems, most frequently requiring a crane or lift. Minnesota DOT mentioned the use of a vendor-supplied barrier-lifting device to load its Road Zipper concrete reactive tension system barrier. Most systems are stackable, with the exception of:

- Arizona's precast concrete barrier.
- Indiana's unspecified temporary concrete barrier that can be anchored or unanchored.
- Minnesota's F-shape portable concrete barrier.
- Tennessee's portable concrete barrier and bridge-mounted interconnected portable barrier rail.

The number of sticks that can be loaded in a single truckload ranged from two to three for Arizona's 20-foot precast concrete barrier to approximately 40 for Indiana DOT's Road Zipper concrete barrier system.

Respondents also rated the ease of transporting their barrier systems. Only the North Carolina DOT respondent rated the agency's water-filled and steel barrier systems as extremely easy to transport. Other respondents rated their barrier systems as somewhat easy or not so easy to transport or did not respond to the question.

Construction and on-site repair (see page 22). Respondents rated the ease and speed of construction of their barrier systems. Respondents were most likely to rate their systems as somewhat easy and somewhat fast to construct. North Carolina DOT's respondent offered the highest ratings among respondents for the agency's water-filled and steel barrier systems, which were rated extremely easy to construct, and extremely fast or very fast to construct.

Most of the agencies' barrier systems can be repaired and maintained on-site. Those that can't are:

- Arizona's precast concrete barrier.
- Minnesota's F-shape portable concrete barrier.
- Minnesota's Road Zipper concrete reactive tension system barrier.
- North Carolina's water-filled barrier.

Repair, maintenance and inspection (see page 23). Respondents were asked to describe the typical repairs and maintenance associated with their barrier systems, and whether the systems could be inspected on-site without dismantling.

Respondents' barrier systems, or sections of them, are more likely to be replaced than repaired, though a few respondents indicated that minor repairs will be made. Two respondents (Indiana and North Carolina DOTs) noted that repositioning or realignment was required after hits or traffic changes, and in Pennsylvania, contractors are responsible for installation and maintenance.

Life expectancy and sustainability (see page 25). Respondents' estimates of the life expectancy of their barrier systems were provided in the number of projects (one to two jobs for North Carolina's water-filled barriers; five to six jobs for Minnesota's F-shape portable concrete barrier) or years (eight years for Arizona's precast concrete barrier; 10 or more years for Indiana's unspecified temporary concrete barrier and Road Zipper concrete barrier system; and 50 years for Pennsylvania's F-shape concrete median barrier).

Only three respondents addressed recycle and disposal options when a barrier system's useful life has ended. In Arizona, these barriers are reused in the maintenance yard or discarded. The Minnesota and Pennsylvania DOT respondents noted the concrete from these systems can be crushed and the steel (rebar) removed and scrapped or recycled.

Plans, Drawings and Other Guidance

Citations for publications provided by survey respondents, including plans, drawings, manuals, specifications and other guidance related to respondents' use of temporary construction barrier systems, begin on page 28.

Survey of Barrier Vendors

An online survey that sought information about temporary construction barrier systems was distributed to four vendors known to provide these products to the transportation community. Three vendors responded to the survey: Hill and Smith, Inc., Safe Barriers North America LLC and Saferoads. Respondents described six MASH-compliant temporary construction barriers marketed by their firms:

- Defender Barrier 70 (Safe Barriers).
- Defender Barrier 100 HC (Safe Barriers).
- Defender Barrier 100 LDS (Safe Barriers).
- HV2 (Saferoads).
- ZoneBloc temporary concrete barrier (Hill and Smith).
- Zoneguard steel barrier (Hill and Smith).

Note: Safe Barriers markets four barrier systems that can be configured with the firm's one steel barrier shell; only three were described in the survey. The firm's one barrier skin can be deployed in multiple ways, allowing one product to meet the requirements of MASH TL-2 to MASH TL-4.

Unlike the state DOT survey respondents, who were more likely to describe a concrete temporary construction barrier, five of the six barrier systems described by vendors are made of steel. Three vendor barriers are also addressed in other sections of this report:

- *Defender Barrier 70*. Hardware testing is described in the MASH implementation database provided by the Roadside Safety Pooled Fund; see page 42 for further information.
- *HV2*. Used by New Mexico DOT. Hardware testing is described in the MASH implementation database provided by the Roadside Safety Pooled Fund; see page 42 for further information.
- *Zoneguard steel barrier*. Used by Minnesota, New Mexico and Tennessee DOTs. Hardware testing is described in the MASH implementation database provided by the Roadside Safety Pooled Fund; see page 42 for further information.

Tables describing the six vendor barrier systems begin on page 34. Table ES2 provides selected details of each barrier system.

Table ES2. Selected Details of Vendor Barrier Systems

Barrier System	Description
Defender Barrier 70 (Safe Barriers)	**System Description** Steel barrier with removable concrete ballast; stackable free-standing system. **Repairs, Maintenance and Inspection** Damaged barriers can be replaced on-site; vendor notes that no maintenance is necessary. Once installed, the system needs only periodic inspection, which can be done on-site without dismantling. **Environmental Concerns** Barrier can be deployed in any climate zone. Robots used to minimize steel waste during construction; scrap steel saved for use with future ballast box design. No environmental product declarations. At the end of its useful life, the steel can be recycled as scrap steel. **Estimated Life Expectancy** 20 years
Defender Barrier 100 HC (Safe Barriers)	**System Description** Steel barrier; stackable pinned system. **Repairs, Maintenance and Inspection** Damaged barriers can be replaced on-site; vendor notes that no maintenance is necessary. Once installed, the system needs only periodic inspection, which can be done on-site without dismantling. **Environmental Concerns** Barrier can be deployed in any climate zone. Robots used to minimize steel waste during construction; scrap steel saved for use with future ballast box design. No environmental product declarations. At the end of its useful life, the steel can be recycled as scrap steel. **Estimated Life Expectancy** 20 years
Defender Barrier 100 LDS (Safe Barriers)	**System Description** Steel barrier; stackable pinned system. **Repairs, Maintenance and Inspection** Damaged barriers can be replaced on-site; vendor notes that no maintenance is necessary. Once installed, the system needs only periodic inspection, which can be done on-site without dismantling.

Barrier System	Description
Defender Barrier 100 LDS (Safe Barriers)	**Environmental Concerns** Barrier can be deployed in any climate zone. Robots used to minimize steel waste during construction; scrap steel saved for use with future ballast box design. No environmental product declarations. At the end of its useful life, the steel can be recycled as scrap steel. **Estimated Life Expectancy** 20 years
HV2 (Saferoads)	**System Description** Barrier with combination of steel and concrete; stackable, free-standing system. **Repairs, Maintenance and Inspection** Can be repaired on-site, though few repairs have been reported. Inspection can be done on-site without dismantling. **Environmental Concerns** Climate does not impact barrier use. Environmental impact of production process unknown. No environmental product declarations; sustainability benefits have not been documented. **Estimated Life Expectancy** 25 years
ZoneBloc (Hill and Smith)	**System Description** Temporary concrete barrier with combination of steel and concrete; stackable free-standing system. **Repairs, Maintenance and Inspection** Can be repaired on-site; damaged sticks can be replaced if needed. Little to no maintenance for the steel and concrete. Can be inspected on-site without dismantling. **Environmental Concerns** Drainage and snow accumulation are considerations in barrier placement. Environmental impact of production process unknown. No environmental product declarations; sustainability benefits have not been documented. The complete system of concrete and steel can be recycled. **Estimated Life Expectancy** Galvanized coatings on typical structural members can exceed 50 years in most rural environments; 20 to 25 years or more in severe urban and coastal exposure.

Barrier System	Description
Zoneguard (Hill and Smith)	**System Description** Steel barrier; stackable pinned system. **Repairs, Maintenance and Inspection** Can be repaired on-site, though repairs are typically not necessary for design impacts. The system needs little to no scheduled maintenance. Inspection can be done on-site without dismantling. **Environmental Concerns** Drainage and snow accumulation are considerations in barrier placement. Environmental impact of production process unknown. No environmental product declarations; sustainability benefits have not been documented. The complete system can be recycled as scrap steel. **Estimated Life Expectancy** Galvanized coatings on typical structural members can exceed 50 years in most rural environments; 20 to 25 years or more in severe urban and coastal exposure.

MASH-Compliant Portable Barriers

The Roadside Safety Pooled Fund maintains a database of testing information for a wide range of roadside hardware, including breakaway devices, crash cushions, work zone traffic control devices and longitudinal barriers such as the portable (or temporary) barriers of interest to Caltrans.

The pooled fund's MASH implementation database (available at https://www.roadsidepooledfund.org/mash-implementation/search/) allows the user to conduct targeted searches, limiting search results by the type of device, test level, eligibility letter and ownership (whether the device is proprietary or nonproprietary).

Table 12, which begins on page 39, lists the relevant results of a targeted MASH implementation database inquiry to identify portable barriers that passed relevant testing criteria. More than two-thirds of the 52 barriers listed in this table are concrete. Slightly more than one-quarter of the barriers are made of steel; one barrier system is described as concrete or steel; and one barrier system is water-filled.

Each table entry includes a link to the MASH implementation database that provides further details of each barrier system. Most of these web pages include a link to a report detailing test results.

Related Research and Resources

Supplementing the survey results are documents sourced through a limited literature search. These resources include AASHTO's 2016 Manual for Assessing Safety Hardware and 2011 Roadside Design Guide. National Cooperative Highway Research Program (NCHRP) project reports describe the performance of portable concrete barrier and recommended procedures for evaluating the safety performance of various highway safety features. FHWA publications

provide guidelines for work zone designers selecting temporary barriers and guidance on applying positive protection deflection distances.

Publications highlighting state research and practices include policies, guidelines and manuals; reports describing examinations of portable concrete barrier condition and mobile and low-profile barrier systems; and the approved temporary barriers used by states not participating in this project's survey.

A sampling of the research performed by the Midwest Roadside Safety Facility, which is accredited to conduct safety performance evaluations on roadside hardware, includes reports describing a retrofit temporary concrete barrier system, a pinned anchoring system for a temporary concrete barrier, and the termination and anchorage of temporary concrete barriers. Other related research examines the performance of a precast slim temporary concrete barrier and the transition between guardrail and portable concrete barrier systems.

Gaps in Findings

The survey of state DOTs received a limited response, with only nine respondents providing details of the temporary construction barriers in use in their states, most often concrete barriers. The vendor survey was distributed to a small number of industry contacts who, for the most part, described only steel barriers. Gathering information from state agencies with more and varied experiences with temporary construction barriers and other vendors offering different types of temporary construction barriers could provide additional details to inform Caltrans' assessment of the temporary construction barriers available for use.

Next Steps

Moving forward, Caltrans could consider:

- Following up with responding agencies to learn more about their use of temporary construction barriers, in particular:
    - Why concrete barrier appears to be preferred over steel for typical use.
    - The specific circumstances that prompt selection of one type of temporary construction barrier over another. For example, the Indiana DOT respondent noted that the agency has started an initiative to use the Lindsay Transportation Solutions Road Zipper concrete barrier system for pavement patching done in work zones.
    - Any efforts underway to modify current policies and practices for temporary construction barrier selection.
- Examining the initial findings from the MASH implementation database available on the Roadside Safety Pooled Fund web site to gather more details of the temporary construction barriers available for use, including the barriers' testing requirements and test results.
- Reviewing the plans, drawings and other guidance provided by survey respondents and sourced through the limited literature search for relevance to Caltrans' needs.
- Consulting with selected survey respondents to discuss proprietary use issues and applicable requirements if Caltrans chooses to use another state DOT's barrier design.
- Seeking information from other state agencies and temporary construction barrier vendors.

Detailed Findings

Background

The California Department of Transportation (Caltrans) is adopting the recommendation put forth by the American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) to apply the Manual for Assessing Safety Hardware (MASH) when evaluating temporary construction barriers. All devices manufactured after December 31, 2019, must have been successfully tested to meet MASH requirements. Devices manufactured before this date and successfully tested to NCHRP Report 350 requirements (i.e., concrete Type K temporary railing) may continue to be used throughout their normal service lives.

To date, Caltrans has selected concrete temporary construction barriers, but the new requirement to adopt MASH-compliant barrier gives Caltrans the opportunity to consider all options now available—steel, concrete and various combinations of materials and shapes. Besides safety, maintainability, ease of use and cost, Caltrans is also considering sustainability and other factors to determine the final selection.

To assist Caltrans in gathering information about suitable barriers, CTC & Associates conducted two online surveys:

- **State departments of transportation (DOTs)**. This survey examined state transportation agency use of temporary construction barriers.
- **Barrier vendors**. A survey of the following vendors sought information about the vendors' temporary construction barrier products:
    - Hill and Smith, Inc.
    - Rockingham Precast, Inc.
    - Safe Barriers North America LLC.
    - Saferoads.

Supplementing survey findings is an examination of information available from two pooled fund studies, including research conducted by the Midwest Roadside Safety Facility and MASH compliance data provided by Roadside Safety Pooled Fund.

While this Preliminary Investigation did not include a formal literature search, this report includes selected publications identified in the course of completing this investigation and publications provided by survey respondents.

Results from these efforts are presented in this Preliminary Investigation in four areas:

- Survey of state practice.
- Survey of barrier vendors.
- MASH-compliant portable barriers.
- Related research and resources.

Survey of State Practice

An online survey was distributed to state DOT members of the AASHTO Committee on Traffic Engineering. The survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

Summary of Survey Results

Ten state DOTs responded to the survey:

- Arizona.
- Arkansas.
- Indiana.
- Minnesota.
- Missouri.
- New Mexico.
- North Carolina.
- Pennsylvania (two responses).
- Tennessee.
- Wisconsin.

Nine of the 10 respondents provided details of the temporary construction barriers used by their agencies.

Instead of providing details of the barriers in use, the Missouri DOT respondent noted that his agency does not choose barrier systems but allows different barrier types as long as the barrier meets NCHRP Report 350 or MASH testing requirements. A proposed barrier is reviewed against the agency's performance specifications and is expected to adequately protect a drop-off, workers and equipment, and meet deflection requirements. The respondent noted that "[p]redominately, the industry uses concrete barriers, but lately we have seen steel barrier systems on projects."

Survey results are summarized below in the following topic areas:

- Policies for barrier selection.
- Impact of climate on barrier selection.
- Respondents' temporary construction barrier systems.
    - General description.
    - System composition.
    - Loading and transport.
    - Construction and on-site repair.
    - Repair, maintenance and inspection.
    - Life expectancy and sustainability.
- Plans, drawings and other guidance.

Policies for Barrier Selection

Respondents described their agencies' policies regarding the selection of temporary construction barriers. Some respondents included in this description how the decision to use concrete or steel is made. Table 1 summarizes survey responses.

Table 1. Agency Policies for Temporary Barrier Selection

State	Agency Policy
Arizona	The agency uses concrete barriers in work zones; other barriers are selected based on the scope of the project.
Arkansas	Barrier need is based on factors identified in: • AASHTO's Roadside Design Guide. • FHWA's Manual for Uniform Traffic Control Devices. The agency uses concrete barriers in all applications where barriers are needed adjacent to work zones. Until January 1, 2020, the selection of temporary concrete barriers was based on compliance with NCHRP 350. Beginning January 1, 2020, barrier selection is based on compliance with MASH 2016.
Indiana	Agency specifications describe four barrier types: • *Type 1*. To separate directions of travel; must be concrete. • *Type 2*. To separate traffic from the work zone; can be either concrete or steel, provided the barrier is crashworthy and its deflection is appropriate. • *Type 3*. Type 1 barrier that will be left in place permanently. • *Type 4*. Movable wall; can be either concrete or steel, provided the barrier is crashworthy and its deflection is appropriate. Contractors choose the source/supplier of the wall and must certify that the wall meets agency specifications. Barrier is used anytime two-way traffic is being maintained on the same side of a freeway. Standard specifications also require its use on freeways for shoulder closures and pavement drop-offs greater than 5" and within 4' of the near travel lane. Barrier is also used to protect slopes and fixed objects that are within the construction clear zone. Truck-mounted attenuators (TMAs) are used with shadow vehicles as part of mobile operations in a travel lane, and the agency is beginning to deploy movable barrier to protect pavement patching operations.
Minnesota	Moving forward, barriers used by the agency must be deemed crashworthy by MASH. The respondent noted that "most contractors have a supply of MASH-compliant portable concrete barrier. This is our default choice; if there is a compelling reason, the designer may choose steel (i.e., added weight of barrier on bridge deck) or movable barrier." The agency has used movable barrier on multiple projects over the past few years.
New Mexico	Concrete barriers are used for the majority of applications. Steel barriers are used when there is a restriction for weight of the barrier.
North Carolina	Agency contractors traditionally use concrete barrier. Steel products are included in the agency's approved products list, but contractors do not regularly use them.
Pennsylvania	Temporary barriers used along state highways must be MASH 2016-compliant or NCHRP 350-compliant if produced prior to December 31, 2019. The department is finalizing a policy that will establish sunset dates for devices not meeting the MASH 2016 requirements. Designers will select the appropriate barrier based on the manufacturer's specifications on deflection distances as indicated by the completed crash testing.
Tennessee	The agency uses all category 3 products with less than 6' unrestrained deflection

State	Agency Policy
	regardless of the material type for barriers categorized as a "WZ [work zone] positive protection device."
Wisconsin	The agency's Facilities Development Manual describes concrete barrier temporary precast (CBTP) as "effective in providing positive separation between traffic and the work area. When used appropriately, CBTP has the potential to reduce the severity of crashes. However, the CBTP itself and the proximity of the end of the CBTP can also be a hazard to traffic. Whenever feasible, it is preferable to remove the hazard and avoid the need for CBTP."

Impact of Climate on Barrier Selection

Respondents were asked to describe how climate and climate zones affect their agencies' selection of temporary construction barriers. Climate is not a factor for most respondents. Table 2 summarizes survey responses.

Table 2. Impact of Climate on Agency Selection of Temporary Construction Barriers

Impact of Climate	State	Details
Climate IS a Factor in Selecting Temporary Construction Barriers	Pennsylvania, Wisconsin	*Pennsylvania*. All barriers must be slotted to allow for water drainage during inclement weather or for projects that remain active or where temporary traffic patterns are present during the winter months. *Wisconsin*. The agency does not allow water-filled barriers of any type.
Climate IS NOT a Factor in Selecting Temporary Construction Barriers	Arizona, Arkansas, Indiana, Minnesota, New Mexico, North Carolina, Tennessee	*Indiana*. Variations in climate are "not prevalent" in the agency's decision-making. *Tennessee*. No climate-related guidance is provided.

Respondents' Temporary Construction Barrier Systems

Five respondents described a MASH-compliant concrete barrier as the type of temporary construction barrier most commonly used by their agencies. A few respondents reported on multiple material types used in temporary barrier installations.

Several respondents noted that their agencies use more than one type of temporary construction barrier:

- Two systems—Indiana.
- Three systems—New Mexico.
- Four systems—Tennessee.
- More than four systems—Minnesota, North Carolina and Pennsylvania.

Table 3 identifies the temporary construction barriers respondents described in survey responses. The six tables that begin on page 16 provide details of these temporary construction barrier systems.

Table 3. Respondents' Temporary Construction Barrier Systems

State	MASH Compliant	System Name/Vendor	Material
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete
Arkansas	No	Concrete barrier wall (New Jersey shape) Vendor not specified	Concrete
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors	Concrete
Indiana	Yes	Road Zipper system Lindsay Transportation Solutions	Concrete
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete
Minnesota	Yes	18" Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel
New Mexico	Yes	Unspecified concrete barrier Vendor not specified	Concrete
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, Test Level 3 (TL-3)) Nonproprietary system	Combination of steel and concrete
Tennessee	No	Portable concrete barrier Vendor not specified	Concrete
Tennessee	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified
Wisconsin	Pending	Concrete barrier temporary precast 12' 6" Vendor not specified	Concrete

Tables 4 through 9 provide details of the temporary construction barriers respondents described in their survey responses. Their responses are organized into the following topic areas, with a table for each topic area:

- General description.
- System composition.
- Loading and transport.
- Construction and on-site repair.
- Repair, maintenance and inspection.
- Life expectancy and sustainability.

Not all respondents provided information for all topic areas. An "N/R" designation in the tables that follow indicates "No Response."

General information about the barrier systems is repeated in the first four columns of each table (state, MASH-compliant, system name/vendor and material). Each table also includes the same five footnoted entries. Footnote descriptions appear once, after Table 9, page 26.

Temporary Construction Barriers: General Description

Table 4. Temporary Construction Barriers: General Description

State	MASH Compliant	System Name/Vendor	Material	Pinned or Free Standing	Frequency of Use
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete	Pinned	Any project that needs concrete barrier uses this system.
Arkansas	No	Concrete barrier wall (New Jersey shape) Vendor not specified	Concrete	Pinned	N/R
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors[1]	Concrete	Free-standing	Numerous
Indiana	Yes	Road Zipper system[2] Lindsay Transportation Solutions	Concrete	Free-standing	Two projects during the 2019 construction season; several projects before that.

State	MASH Compliant	System Name/Vendor	Material	Pinned or Free Standing	Frequency of Use
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete	Free-standing	99% of projects that use barrier
Minnesota	Yes	18" Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete	Free-standing	10 projects
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel	Pinned	1 project
New Mexico[3]	Yes	Unspecified concrete barrier Vendor not specified	Concrete	Free-standing	Concrete "used mostly"; steel used on 1 or 2 projects; plastic water-ballasted barrier used several times.
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete	Free-standing	Most commonly used product; used on "countless projects."
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension	Free-standing	"Countless" projects
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel	Free-standing	Fewer than 10 projects
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, TL-3) Nonproprietary system[4]	Combination of steel and concrete	Free-standing	Thousands of projects
Tennessee[5]	No	Portable concrete barrier Vendor not specified	Concrete	Free-standing	1,000+ projects
Tennessee[5]	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified	Free-standing	3 to 4 projects
Wisconsin	Pending	Concrete barrier temporary precast 12' 6" Vendor not specified	Concrete	Free-standing	N/R

Temporary Construction Barriers: System Composition

Table 5. Temporary Construction Barriers: System Composition

State	MASH Compliant	System Name/Vendor	Material	Stick Length	Stick Width	Stick Weight	Maximum Dynamic Deflection Distance
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete	• 12’ 6” • 20’	Top: 9.5’ Base: 2’	N/R	0 to 1’
Arkansas	No	Idaho Precast Concrete Barrier Wall (New Jersey Shape) Vendor not specified	Concrete	20’	Top: 6” Base: 2’	3.9 tons	43”
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors[1]	Concrete	10’	Base: 2’	4,000 lbs	12” to 13” (anchored)
Indiana	Yes	Road Zipper system[2] Lindsay Transportation Solutions	Concrete	1 m (3.28’)	Base: 18”	1,500 lbs	2’
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete	12’ 5”	Top: 8” Base: 1’ 10.5”	~7,100 lbs	• 80” unpinned • 38” for tie-down strap anchor • 16” for pins
Minnesota	Yes	18” Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete	39”	18”	~1,500 lbs	41”
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel	16’ 8”	2’ 3-9/16”	50’ unit = 3,097 lbs	• 0.41 m (minimum deflection pin set-up) • 1.93 m (standard deflection pin set-up)

State	MASH Compliant	System Name/Vendor	Material	Stick Length	Stick Width	Stick Weight	Maximum Dynamic Deflection Distance
New Mexico[3]	Yes	Unspecified concrete barrier Vendor not specified	Concrete	Pending on deflection requirements it can be pinned or unpinned; if pinned varies between 1' 8" to 2.5'	Unclear response	N/R	Varies between 10" to 65" based on type and anchoring
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete	10'	24"	~7,000 lbs	~48", depending on impact angle and speeds
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension	~10'	24"	~3,800 lbs	14'
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel	20'	24"	Unknown	4'
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, TL-3) Nonproprietary system[4]	Combination of steel and concrete	12' 0" minimum (most common); 30' 0" maximum	2' 0"	Unknown	8.4' (refer to FHWA Eligibility Letter B-79)
Tennessee[5]	No	Portable concrete barrier Vendor not specified	Concrete	10' to 20'	2' 3"	10' = 4,860 lbs 20' = 9,720 lbs	5' (NCHRP 350 TL-3)
Tennessee[5]	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified	Variable	See the standard	N/R	2'
Wisconsin	Pending	Concrete barrier temporary precast 12' 6" Vendor not specified	Concrete	12' 6"	1' 10.5"	2.7 tons	8' 7"

Temporary Construction Barriers: Loading and Transport

Table 6. Temporary Construction Barriers: Loading and Transport

State	MASH Compliant	System Name/Vendor	Material	Equipment Needed to Load/Unload	Stackable System	Sticks in a Single Truckload	Ease of Transport
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete	Wall picker or crane	No	When loading in a semi: • 12' 6" = 3 to 4 sticks • 20' = 2 to 3 sticks	Somewhat easy
Arkansas	No	Idaho Precast Concrete Barrier Wall (New Jersey Shape) Vendor not specified	Concrete	Tractor trailer	Yes	N/R	Not so easy
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors[1]	Concrete	Crane	No	No more than 15	Not so easy
Indiana	Yes	Road Zipper system[2] Lindsay Transportation Solutions	Concrete	Load transfer machine	Yes	~40	Not so easy
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete	Flatbed truck and boom truck	No	9	Somewhat easy
Minnesota	Yes	18" Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete	Barrier should be stacked with a forklift and vendor-supplied barrier-lifting device	Yes	Depends on truck/trailer	N/R
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel	N/R	Yes	3 bundles in a truckload (1 bundle = 5 units)	N/R
New Mexico[3]	Yes	Unspecified concrete barrier Vendor not specified	Concrete	N/R	Yes	Varies	Somewhat easy
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete	Excavator with a scissor clamp	Yes	~8	Somewhat easy

State	MASH Compliant	System Name/Vendor	Material	Equipment Needed to Load/Unload	Stackable System	Sticks in a Single Truckload	Ease of Transport
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension	By hand	Yes	Several dozen	Extremely easy
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel	Unknown	Yes	N/R	Extremely easy
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, TL-3) Nonproprietary system[4]	Combination of steel and concrete	Crane and front-end loader	Yes	Depends on contractor's equipment	Somewhat easy
Tennessee[5]	No	Portable concrete barrier Vendor not specified	Concrete	Lift	No	N/R	Somewhat easy
Tennessee[5]	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified	Lift	No	N/R	Somewhat easy
Wisconsin	Pending	Concrete barrier temporary precast 12' 6" Vendor not specified	Concrete	N/R	Yes	N/R	N/R

Temporary Construction Barriers: Construction and On-Site Repair

Table 7. Temporary Construction Barriers: Construction and On-Site Repair

State	MASH Compliant	System Name/Vendor	Material	Ease of Construction	Speed of Construction	Repair and Maintain On Site
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete	Somewhat easy	Very fast	No
Arkansas	No	Idaho Precast Concrete Barrier Wall (New Jersey Shape) Vendor not specified	Concrete	Not so easy	Not at all fast	Yes
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors[1]	Concrete	Not so easy	Not so fast	Yes
Indiana	Yes	Road Zipper system[2] Lindsay Transportation Solutions	Concrete	Very easy	Somewhat fast	Yes
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete	Very easy	Not so fast	No
Minnesota	Yes	18” Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete	N/R	N/R	No
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel	N/R	N/R	N/R
New Mexico[3]	Yes	Unspecified concrete barrier Vendor not specified	Concrete	Somewhat easy	Somewhat fast	Yes
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete	Very easy	Somewhat fast	Yes
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension	Extremely easy	Very fast	No

State	MASH Compliant	System Name/Vendor	Material	Ease of Construction	Speed of Construction	Repair and Maintain On Site
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel	Extremely easy	Extremely fast	Yes
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, TL-3) Nonproprietary system[4]	Combination of steel and concrete	Somewhat easy	Somewhat fast	Yes
Tennessee[5]	No	Portable concrete barrier Vendor not specified	Concrete	Somewhat easy	Somewhat fast	Yes
Tennessee[5]	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified	Somewhat easy	Somewhat fast	Yes

Temporary Construction Barriers: Repair, Maintenance and Inspection

Table 8. Temporary Construction Barriers: Repair, Maintenance and Inspection

State	MASH Compliant	System Name/Vendor	Material	Typical Repairs	Typical Maintenance	Inspection On Site Without Dismantling
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete	Patch minor repair; otherwise discard.	No regular maintenance; inspection completed before dispatch and installation.	On-site inspection done regularly. Intact system can be inspected without dismantling. System that has been hit cannot be inspected without dismantling.
Arkansas	No	Idaho Precast Concrete Barrier Wall (New Jersey Shape) Vendor not specified	Concrete	N/A	N/A	N/A

State	MASH Compliant	System Name/Vendor	Material	Typical Repairs	Typical Maintenance	Inspection On Site Without Dismantling
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors[1]	Concrete	Replace with new 10' section.	Reposition, adjusting for maintenance of traffic phase changes.	Yes
Indiana	Yes	Road Zipper system[2] Lindsay Transportation Solutions	Concrete	Replace sections; repair the transfer machine (particularly older models).	Unjam sections while being deployed by the transfer machine.	Yes
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete	Replace.	Add/replace delineators as needed.	Yes
Minnesota	Yes	18” Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete	N/R	N/R	Yes
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel	N/R	N/R	Yes
New Mexico[3]	Yes	Unspecified concrete barrier Vendor not specified	Concrete	Varies; repair and smooth snag points.	Require contractor-provided systems that are new, in “good shape” or replace.	Yes
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete	Make small repairs in response to damage caused by hits.	Realign segments after hits; clean debris from drainage slots.	Yes
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension	Replace damaged units after a strike.	Ensure water level is full; clear debris from drainage slots.	Yes
North Carolina	Yes	Steel barrier Varies, agency does not specify vendors or manufacturers	Steel	No knowledge of any repairs made.	No knowledge of any maintenance needed.	Yes

State	MASH Compliant	System Name/Vendor	Material	Typical Repairs	Typical Maintenance	Inspection On Site Without Dismantling
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, TL-3) Nonproprietary system[4]	Combination of steel and concrete	Typically, remove damaged barriers and replace with a new unit.	Contractors typically install and maintain.	Yes
Tennessee[5]	No	Portable concrete barrier Vendor not specified	Concrete	Usually replace.	None	Yes
Tennessee[5]	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified	Replace not repair.	Replace not repair.	Yes

Temporary Construction Barriers: Life Expectancy and Sustainability

Table 9. Temporary Construction Barriers: Life Expectancy and Sustainability

State	MASH Compliant	System Name/Vendor	Material	Estimated Life Expectancy	Recycle and Disposal Options
Arizona	Yes	Precast concrete barrier Howe Precast Concrete Barriers, Inc.	Concrete	Lifetime without damage; in real-world terms, approximately 8 years.	Barrier is used in the maintenance yard or discarded.
Arkansas	No	Idaho Precast Concrete Barrier Wall (New Jersey Shape) Vendor not specified	Concrete	N/R	N/R
Indiana	Yes	Unspecified temporary concrete barrier that can be unanchored or anchored (anchoring is standard treatment on bridge decks and bridge approaches) Various vendors[1]	Concrete	10+ years	N/R
Indiana	Yes	Road Zipper system[2] Lindsay Transportation Solutions	Concrete	10+ years; some permanent applications have been in place since 1990.	N/R

State	MASH Compliant	System Name/Vendor	Material	Estimated Life Expectancy	Recycle and Disposal Options
Minnesota	Yes	F-shape portable concrete barrier Nonproprietary system	Concrete	5 to 6 jobs	Rebar can be scrapped; concrete can be crushed.
Minnesota	Yes	18” Road Zipper (concrete reactive tension system barrier) Lindsay Transportation Solutions	Concrete	Unknown; this system is rented for each project and the contractor deals with most issues.	N/R
Minnesota	Yes	Zoneguard Hill and Smith, Inc.	Steel	Unknown; when used on one project, the contractor rented it.	N/R
New Mexico[3]	Yes	Unspecified concrete barrier Vendor not specified	Concrete	N/R	N/R
North Carolina	Yes	F-shape portable concrete barrier Varies; agency does not specify vendors or manufacturers	Concrete	Unknown	Unknown
North Carolina	Pending	Water-filled barrier Varies; agency does not specify vendors or manufacturers	Water-ballasted plastic with internal steel frame, external steel frame or cable tension	1 to 2 projects	Unknown
North Carolina	Yes	Steel barrier Varies; agency does not specify vendors or manufacturers	Steel	N/R	N/R
Pennsylvania	No	RC-57M (concrete median barrier, F-shape) RC-59M (concrete glare screen, F-shape; NCHRP 350, TL-3) Nonproprietary system[4]	Combination of steel and concrete	50 years	Concrete is crushed and steel removed; material is recycled.
Tennessee[5]	No	Portable concrete barrier Vendor not specified	Concrete	N/R	N/R
Tennessee[5]	Yes	Bridge-mounted interconnected portable barrier rail Vendor not specified	Not specified	N/R	N/R

1 Indiana DOT obtains its unspecified temporary concrete barrier from various vendors appearing on the agency’s list of Certified Precast Concrete Producers; system selection is guided by the agency’s Standard Specifications.

2 The Lindsay Road Zipper system hasn’t been formally adopted into Indiana DOT’s standards, but the agency has started an initiative to use it on a more consistent basis for certain work zones such as pavement patching.

3 New Mexico DOT uses contractor-provided concrete barriers for the majority of installations, specifying that the barriers must be “in good shape or new.” The respondent indicated that the agency also uses two types of steel barriers: HV2 steel with concrete ballast safety barrier available from Saferoads, and Zoneguard from Hill and Smith, Inc., along with an unspecified water-ballasted plastic barrier system. The respondent did not provide details of these barrier systems.

4 Pennsylvania DOT’s approved proprietary systems, used on hundreds of projects and composed of concrete, steel and/or water-ballasted plastic, are listed in Bulletin 15 (Publication 35), Qualified Products List for Construction, for the following: Temporary Barrier, Concrete; Temporary Barrier, Concrete—Retrofit Systems to Limit Deflection; Temporary Barrier, Steel; and Temporary Barrier, Water-Filled. Approved vendors for these systems are listed in Bulletin 15. The respondent noted that some systems meet MASH requirements. See page 31 for more information.

5 Tennessee DOT has also used Zoneguard, a steel, free-standing barrier system, for fewer than 10 installations, but the respondent did not provide details of this system. The Minnesota DOT and New Mexico DOT respondents also reported use of Zoneguard; only the Minnesota DOT respondent provided details of this temporary barrier system.

Plans, Drawings and Other Guidance

The publications cited below, provided by survey respondents, include plans, drawings, manuals and other guidance related to respondents' use of temporary construction barrier systems.

Arizona

Precast Concrete Barrier: Structural Details, Arizona Department of Transportation, June 2014.
https://apps.azdot.gov/files/Traffic/SigningMarking/current/c-03a-June-14.pdf
This standard drawing provides the structural details for the temporary concrete barrier described by the Arizona DOT respondent.

Precast Concrete Barrier: Pin and Loop Assembly, Arizona Department of Transportation, June 2014.
https://apps.azdot.gov/files/Traffic/SigningMarking/current/c-03b-June-14.pdf
These drawings and notes are related to the pin and loop assembly for the agency's temporary precast concrete barriers. Other supplemental standard drawings are available at https://azdot.gov/business/engineering-and-construction/traffic/signing-and-marking-standard-sms-drawings, including the following:

- Typical end treatment for detours using temporary concrete barrier.
- Approach plate transition section for temporary concrete barrier.

Arkansas

Temporary Precast Barrier, Standard Drawing TC-4, Standard Traffic Controls for Highway Construction, Arkansas State Highway Commission, February 2014.
http://www.arkansashighways.com/roadway_design_division/usunits/79-tc-4.pdf
This is the standard drawing for the state's temporary concrete barrier. General Notes indicate that "[o]ther Precast Concrete Barriers that have been crash tested and approved by the Federal Highway Administration to meet the requirements of NCHRP-350 test level 3 or Manual for Assessing Safety Hardware (MASH) will be accepted in lieu of the barrier shown."

Indiana

Chapter 503, Maintenance of Traffic, Indiana Design Manual, Indiana Department of Transportation, 2013.
https://www.in.gov/indot/design_manual/files/Ch503_2013.pdf
See page 53 for a description of four types of temporary traffic barrier and the design layout.

Division 800, Traffic Control Devices and Lighting, 2020 Standard Specifications, Indiana Department of Transportation, September 2019.
https://www.in.gov/dot/div/contracts/standards/book/sep19/800-2020.pdf
See page 818 of the manual (page 8 of the PDF) for Section 801.10, Temporary Traffic Barriers.

Temporary Concrete Barrier Index Sheet, Standard Drawing No. E 801-TCCB-01, Indiana Department of Transportation, September 2019.
https://www.in.gov/dot/div/contracts/standards/drawings/sep19/e/800e/e800%20combined%20pdfs/E801-TCCB.pdf
This document includes drawings and notes associated with temporary concrete barrier dimensions, details and double taper end section, and drawings for a drop-in anchor and ferrule loop insert for an anchored temporary concrete barrier.

Minnesota

Work Zones—TTC [Temporary Traffic Control] Device Standards, Minnesota Department of Transportation, 2020.
http://www.dot.state.mn.us/trafficeng/workzone/ttcdevicestandards.html
This web site provides links to documents describing device standards for portable precast concrete barrier. The web site indicates that a document describing quality standards is under development.

Temporary Barrier Guidance Manual, Minnesota Department of Transportation, December 2018.
http://www.dot.state.mn.us/trafficeng/workzone/doc/Temporary%20Barrier%20Guidance%20Manual%20181129.pdf
Guidance in this manual includes temporary barrier use applications, placement and deflection distance guidelines, and portable concrete barrier design details and requirements.

Chapter 8, Temporary Traffic Control, Traffic Engineering Manual, Minnesota Department of Transportation, August 2015.
http://www.dot.state.mn.us/trafficeng/publ/tem/2019/chapter8.pdf
See Section 8-6.06 Temporary Barriers, which begins on page 8-37 of the manual (page 37 of the PDF).

This section includes a link to an "APL [Approved Products List] for temporary barriers" (see http://www.dot.state.mn.us/products/temporarytrafficcontrol/temporarybarriers.html). The barriers listed on this web page are organized into four categories: portable precast concrete barrier, movable concrete barrier, portable nonconcrete barrier and water-filled barrier.

Note: The Minnesota DOT survey respondent provided the following links to vendor publications relevant to the agency's use of Zoneguard, a Hill and Smith product.

Zoneguard Barrier 50'-0 Unit Dimensions, Hill and Smith, Inc., undated.
https://www.hillandsmith.com/wp-content/uploads/2015/01/1023R0.pdf
This drawing shows plan and elevation views of the Zoneguard steel barrier.

Zoneguard Barrier Truck Loading Details, Hill and Smith, Inc., August 2015.
https://www.hillandsmith.com/wp-content/uploads/2015/01/1009R0.pdf
This drawing that illustrates the vendor's recommendation for loading the Zoneguard steel barrier system onto trucks includes descriptive details of the barrier system.

Technical Docs, Zoneguard, Hill and Smith, Inc., 2018.
https://hillandsmith.com/products/zoneguard/#tech-docs
This web page includes details of the Zoneguard system and links to technical documents, including acceptance letters associated with NCHRP 350 and MASH, standard unit and profile dimensions, identification of speed joints, truck loading details, lifting locations, connection detail, anchoring locations, and anchor types and installation details.

Missouri

Chapter 617.1: Temporary Traffic Barriers, Engineering Policy Guide, Missouri Department of Transportation, January 2019.
http://epg.modot.org/index.php/617.1_Temporary_Traffic_Barriers
This chapter describes temporary concrete traffic barriers, water-filled barriers and movable barrier systems.

Note: The Missouri DOT survey respondent noted that while the agency has not adopted for use any particular barrier system, Missouri DOT provides standard drawings to construct a temporary F-type barrier system as developed by the Midwest Roadside Safety Facility.

New Mexico

Standard Drawings for Highway and Bridge Construction, New Mexico Department of Transportation, 2019.
https://dot.state.nm.us/content/dam/nmdot/Plans_Specs_Estimates/2019_Standard_Drawings.pdf
See the drawings under Temporary Concrete Wall Barrier, 606-36 through 606-45, which begin on page 255 of the PDF. Drawings include the following:

- Temporary precast concrete wall barrier.
- Temporary precast concrete wall barrier details.
- Temporary precast concrete wall barrier anchoring details.
- Concrete barrier mount for square post.
- Temporary precast concrete wall barrier taper rates.

Pennsylvania

Design Manual, Part 2, Highway Design, Publication 13M, Pennsylvania Department of Transportation, September 2018.
http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2013M/September%202018%20Change%20No.%203.pdf
See Chapter 12, Section 12.10, Temporary Barriers, which begins on page 12-48 (page 662 of the PDF). Material and construction requirements begin on page 12-49 (page 663 of the PDF).

Qualified Products List for Construction, Bulletin 15 (Publication 35), Pennsylvania Department of Transportation, February 2020.
http://www.dot.state.pa.us/public/pdf/BOCM_MTD_LAB/PUBLICATIONS/PUB_35/Current_Edition/Bulletin15.pdf
Section 627, Temporary Barrier, begins on page 114. *From the bulletin*:

> For Precast Concrete Barriers, see Section 714.2 for approved precasters of standard PennDOT barriers (RC-57M & RC-58M) or licensed barriers and Glare Screens (RC-59M). Also see Section 901.2 for other approved temporary barriers. Temporary work zone devices manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH. Such devices manufactured on or before this date, and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, may continue to be used throughout their normal service lives.

Other sections related to temporary barrier include:

- Section 714 Precast Concrete Products (page 291).
- Section 901.2 Temporary Barrier, Concrete (DM-2, Chapter 12) (page 412).
- Section 901.2 Temporary Barrier, Concrete—Retrofit Systems to Limit Deflection (DM-2, Chapter 12) (page 418).
- Section 901.2 Temporary Barrier, Steel (DM-2, Chapter 12) (page 422).
- Section 901.2 Temporary Barrier, Water-Filled (DM-2, Chapter 12) (page 427).

Standards for Roadway Construction, Publication 72M, Pennsylvania Department of Transportation, June 2010.
http://www.dot.state.pa.us/public/PubsForms/Publications/Pub%2072M/72M_2010_IE/72M_2010_IE.pdf
This publication is the most recent edition. See drawings for RC-57M, Concrete Median Barrier F-Shape (page 195), and RC-59M, Concrete Glare Screen F-Shape (page 205). Links to periodic revisions of this manual are available at http://www.dot.state.pa.us/public/PubsForms/Publications/PUB%2072M/72M_2010.pdf.

Specifications, Publication 408, Pennsylvania Department of Transportation, April 2016.
https://www.dot.state.pa.us/public/PubsForms/Publications/Pub_408/408_2016/408_2016_IE/408_2016_IE.pdf
Sections of interest in this publication include:

- Section 627, Temporary Barrier (page 627.1 of the manual; page 414 of the PDF).
- Section 628, Reset Temporary Barrier (page 628.1 of the manual; page 415 of the PDF).
- Section 643, Temporary Concrete Barrier, Structure Mounted (page 643.1 of the manual; page 423 of the PDF).
- Section 644, Temporary Concrete Barrier, Structure Mounted, Reset (page 644.1 of the manual; page 430 of the PDF).
- Section 901, Maintenance and Protection of Traffic During Construction (page 901-1 of the manual; page 629 of the PDF).

Tennessee

T-WZ-PBR1, Interconnected Portable Barrier Rail, Design—Traffic Control, Tennessee Department of Transportation, November 2019 (June 2019 effective date for drawing).
https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/design---traffic-control/t-wz-pbr1.html
This web site provides a link to the standard drawing for the agency's precast concrete temporary barrier system and related standard drawings.

Qualified Products List Report, Tennessee Department of Transportation, January 2018.
https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/qpl/QPL%2034_1-3-18.pdf
See Section G, Temp[orary] Workzone Control Channel Devices, for:

- Portable precast concrete barrier products (beginning on page 20).
- Steel barrier products (beginning on page 22).
- Water-filled plastic channelizing devices (beginning on page 24).

MASH Approved Safety Hardware, Product Category 45, Qualified Products List Report, Tennessee Department of Transportation, January 2020.
https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/qpl/QPL_45.pdf
See page 3 for Section F, Category III Work Zone Devices, in this new list of MASH-approved hardware.

Wisconsin

Section 45, Traffic Control; Chapter 1, General Provisions, Construction and Materials Manual, Wisconsin Department of Transportation, November 2019.
https://wisconsindot.gov/rdwy/cmm/cm-01-45.pdf
See page 10 for 1-45.12.5 Temporary Barrier Acceptability, which addresses the review and maintenance of temporary concrete barrier. *From the manual*:

> Criteria in this section describe deficiencies in temporary concrete barrier, and the effect on the quality and usability of the barrier. The guidance is based on three levels of device quality: acceptable, marginal and unacceptable. Temporary concrete barrier introduced to the work site must be in acceptable condition. It may degrade to marginal quality during the project, but once the barrier has been determined to be unacceptable it must be replaced with acceptable barrier. Temporary concrete barrier must be monitored and maintained throughout the course of construction. The contractor is required to provide a level of inspection necessary to ensure ongoing compliance with the quality guidelines.

SDD 14b7-a, Concrete Barrier Temporary Precast, Standard Detail Drawings, Wisconsin Department of Transportation, November 2019.
https://wisconsindot.gov/rdwy/sdd/sd-14b07.pdf
This is the standard drawing for Wisconsin DOT's precast concrete temporary barrier.

Survey of Barrier Vendors

An online survey that sought information about temporary construction barrier systems was distributed to four vendors known to provide these products to the transportation community:

- Hill and Smith, Inc.
- Rockingham Precast, Inc.
- Safe Barriers North America LLC.
- Saferoads.

The survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

Summary of Survey Results

Three vendors responded to the survey: Hill and Smith, Inc., Safe Barriers North America LLC and Saferoads. Respondents described six MASH-compliant temporary construction barriers marketed by their firms:

- Defender Barrier 70 (Safe Barriers).
- HV2 (Saferoads).
- Zoneguard steel barrier (Hill and Smith).
- Defender Barrier 100 HC (Safe Barriers).
- Defender Barrier 100 LDS (Safe Barriers).
- ZoneBloc temporary concrete barrier (Hill and Smith).

Note: The Safe Barriers respondent indicated that his firm markets four barrier systems that can be configured with the firm's one steel barrier shell; only three were described in the survey.

Tables 10 (Set One) and 11 (Set Two) that begin on page 34 provide details of the six barriers described by survey respondents. Some of these barriers are also addressed in other sections of this report:

- *Defender Barrier 70*. Hardware testing is described in the MASH implementation database provided by the Roadside Safety Pooled Fund; see page 42 for further information.
- *HV2*. Used by New Mexico DOT. Hardware testing is described in the MASH implementation database provided by the Roadside Safety Pooled Fund; see page 42 for further information.
- *Zoneguard steel barrier*. Used by Minnesota, New Mexico and Tennessee DOTs. Hardware testing is described in the MASH implementation database provided by the Roadside Safety Pooled Fund; see page 42 for further information.

Table 10. Description of Vendor Barriers: Set One

	Defender Barrier 70	HV2	Zoneguard Steel Barrier
General Description			
Vendor	Safe Barriers North America LLC	Saferoads	Hill and Smith, Inc.
Material	Steel barrier with removable concrete ballast	Combination of steel and concrete	Steel
Pinned or Free-Standing	Free-standing	Free-standing	Pinned
System Composition			
Stick Length	3.9 m (12’ 9.5”)	20’	Standard stick length is 50’; also available in 33’ and 16’ lengths. Miter sections available for custom radius.
Stick Width	680 mm (2’ 2.75”)	18”	Inverted T-shape with 6 3/16” top beam and 27 9/16” base.
Stick Weight	Without ballast boxes: 317 kg (699 lbs); with three ballast boxes included: 1,040 kg (2,293 lbs).	4,600 lbs	Each 50’ stick weighs 3,097 lbs (62 lbs/ft).
Maximum Dynamic Deflection Distance	47.24”	MASH Test Number 4-12, TL-4 = 7.78’	5.0” installed on concrete: Minimum deflection pins at 33’ 23.4”. Installed on asphalt: Minimum deflection pins at 33’ 82”. Standard deflection and pinned at 250’.
Loading and Transport			
Equipment Needed to Load/Unload	Forklift or small crane	Forklift	Forklift (2-ton capacity) or larger equipment
Stackable System	Yes	Yes	Yes
Sticks in a Single Truckload	Data provided for 40’ cargo container, which approximates the average truck size. Ballasted: 24 per container (the limit is weight); unballasted: 42 per container.	Two	750’ per truck 15 50’ sticks can be stacked on each truck.

	Defender Barrier 70	HV2	Zoneguard Steel Barrier
Repair, Maintenance and Inspection			
Repair and Maintain On-Site	Yes	Yes	Yes
Typical Repairs	Damaged barriers in the wall of barriers can be replaced on-site (e.g., if a barrier's skin is ripped or if there is damage to the connection between barriers).	Few repairs have been reported.	Repairs are typically not necessary for design impacts. Damaged individual barrier sticks can be replaced anywhere in the wall if needed.
Typical Maintenance	No maintenance necessary. Once installed, the system only needs to be inspected from time to time.	Steel outer casing is very durable.	The system is constructed of galvanized steel and needs little to no scheduled maintenance.
Inspection On-Site Without Dismantling	Yes	Yes	Yes
Environmental Concerns			
Impact of Climate	None. Vendor's barriers can be deployed in any climate zone.	None.	Drainage and snow accumulation are considerations.
Environmental Impact of Production Process	Robots are used to minimize steel waste during construction. Scrap steel is saved for use with future ballast box design.	Unknown; product manufactured in Korea.	Unknown
Environmental Product Declarations	None	None	None
Sustainability Benefits	The product will last 20 years or longer; at the end of its life cycle, the steel can be recycled as scrap steel. The system is designed to be one barrier skin that can be deployed in any number of ways, thereby allowing one product to cover MASH TL-2 to MASH TL-4.	Not documented	Not documented
Recycle and Disposal Options	The system can be sold as scrap to any existing scrap dealer.	Components are steel and concrete.	The complete system can be recycled as scrap steel.

	Defender Barrier 70	HV2	Zoneguard Steel Barrier
Life Expectancy			
Estimated Life Expectancy	20 years	25 years	Galvanized coatings on typical structural members can exceed 50 years in most rural environments; 20 to 25 years or more in severe urban and coastal exposure.

Table 11. Description of Vendor Barriers: Set Two

	Defender Barrier 100 HC	Defender Barrier 100 LDS	ZoneBloc Temporary Concrete Barrier
General Description			
Vendor	Safe Barriers North America LLC	Safe Barriers North America LLC	Hill and Smith, Inc.
Material	Steel	Steel	Combination of steel and concrete
Pinned or Free-Standing	Pinned	Pinned	Free-standing
System Composition			
Stick Length	3.9 m (12’ 9.5”)	3.9 m (12’ 9.5”)	39.5’ per stick
Stick Width	680 mm (2’ 2.75”)	680 mm (2’ 2.75”)	12”
Stick Weight	320 kg (705.5 lbs)	320 kg (705.5 lbs)	6,614 lbs
Maximum Dynamic Deflection Distance	6.2’	34.6”	44”
Loading and Transport			
Equipment Needed to Load/Unload	Forklift or small crane	Forklift or small crane	Forklift with suitable capacity
Stackable System	Yes	Yes	Yes
Sticks in a Single Truckload	Data provided for 40’ cargo container, which approximates the average truck size: 42 barriers.	Data provided for 40’ cargo container, which approximates the average truck size: 42 barriers.	280’ per truck

	Defender Barrier 100 HC	Defender Barrier 100 LDS	ZoneBloc Temporary Concrete Barrier
Repair, Maintenance and Inspection			
Repair and Maintain On-Site	Yes	Yes	Yes
Typical Repairs	Damaged barriers in the wall of barriers can be replaced on-site (e.g., if a barrier's skin is ripped or if there is damage to the connection between barriers).	Damaged barriers in the wall of barriers can be replaced on-site (e.g., if a barrier's skin is ripped or if there is damage to the connection between barriers).	Damaged sticks can be replaced, if needed, anywhere in the wall.
Typical Maintenance	No maintenance necessary. Once installed, the system only needs to be inspected from time to time.	No maintenance necessary. Once installed, the system only needs to be inspected from time to time.	Little to no maintenance for steel and concrete.
Inspection On-Site Without Dismantling	Yes	Yes	Yes
Environmental Concerns			
Impact of Climate	None. Vendor's barriers can be deployed in any climate zone.	None. Vendor's barriers can be deployed in any climate zone.	Drainage and snow accumulation are considerations.
Environmental Impact of Production Process	Robots are used to minimize steel waste during construction. Scrap steel is saved for use with future ballast box design.	Robots are used to minimize steel waste during construction. Scrap steel is saved for use with future ballast box design.	Unknown
Environmental Product Declarations	None	None	None
Sustainability Benefits	The product will last 20 years or longer; at the end of the life cycle, the steel can be recycled as scrap steel. The system is designed to be one barrier skin that can be deployed in any number of ways, thereby allowing one product to cover MASH TL-2 to MASH TL-4.	The product will last 20 years or longer; at the end of the life cycle, the steel can be recycled as scrap steel. The system is designed to be one barrier skin that can be deployed in any number of ways, thereby allowing one product to cover MASH TL-2 to MASH TL-4.	Not documented
Recycle and Disposal Options	The system can be sold as scrap to any existing scrap dealer.	The system can be sold as scrap to any existing scrap dealer.	Complete system of concrete and steel can be recycled.

	Defender Barrier 100 HC	Defender Barrier 100 LDS	ZoneBloc Temporary Concrete Barrier
Life Expectancy			
Estimated Life Expectancy	20 years	20 years	Galvanized coatings on typical structural members can exceed 50 years in most rural environments; 20 to 25 years or more in severe urban and coastal exposure.

MASH-Compliant Portable Barriers

The Roadside Safety Pooled Fund maintains a database of testing information for a wide range of roadside hardware, including breakaway devices, crash cushions, work zone traffic control devices, and longitudinal barriers, including the portable (or temporary) barriers of interest to Caltrans.

The pooled fund's MASH implementation database (available at https://www.roadsidepooledfund.org/mash-implementation/search/) allows the user to conduct targeted searches, limiting search results by the type of device, test level, eligibility letter and ownership (whether the device is proprietary or nonproprietary). A query of this database using "Portable Barriers" under "Device Type" and "Pass" under "Pass/Fail" (indicating that the device has passed the relevant testing criteria) yielded more than 50 results.

Table 12 lists the relevant results of this targeted MASH implementation database inquiry. Table entries are organized by barrier material, beginning with concrete, and in alphabetical order within each material type. The links below direct the reader to web pages with further details of the barrier and the testing conducted; most pages include a link to a report detailing test results.

Table 12. MASH-Compliant Portable Barriers Included in MASH Implementation Database

Product Name/Link for Further Details	Material	Description
12' T-LOC F-Shape Portable Concrete Barrier https://www.roadsidepooledfund.org/?p=3586	Concrete	Rockingham Precast T-LOC barrier.
31.8" Tall 12" J-J Hooks Free-Standing 19' 8 1/4" Barrier https://www.roadsidepooledfund.org/?p=5876	Concrete	31.8" tall J-J Hooks F-shape free-standing barrier system consists of 11 barrier lengths of 6,000 mm (19' 8 1/4") with reinforcing bars connecting the proprietary connector plates at each end, connected together via proprietary 12" connector plates.
32" F-Shape Concrete Barrier https://www.roadsidepooledfund.org/?p=5102	Concrete	32" F-shape concrete barrier pinned to concrete pavement; 30' barrier segments with J-J Hooks connections.
32" F-Shape Free-Standing Portable Concrete Barrier (PCB) With Cross-Bolt https://www.roadsidepooledfund.org/?p=5276	Concrete	32" F-shape free-standing PCB with cross-bolt and 10' segments.
32" Tall F-Shape Free-Standing PCB https://www.roadsidepooledfund.org/?p=4929	Concrete	32" tall, F-shape profile, free-standing PCB.
32" Tall Stiffened New York State PCB https://www.roadsidepooledfund.org/?p=2492	Concrete	Unanchored temporary construction barrier (TCB) with box beam stiffener.
32" Tall Unstiffened New York State PCB https://www.roadsidepooledfund.org/?p=5212	Concrete	32" tall unstiffened TCB system with anchored ends.
Concrete Tied-Down Anchorage for PCB (MASH 2016) https://www.roadsidepooledfund.org/?p=6092	Concrete	F-shape PCB with a bolt-through, tie-down configuration on concrete tarmac.
Delta Block DB 80 https://www.roadsidepooledfund.org/?p=3199	Concrete	PCB with 12' 6" long units; connected with tension link that consists of two Y-profile hooks and the connecting K150 coupling.

Product Name/Link for Further Details	Material	Description
Evaluation of New Jersey TCB Performance Under MASH TL-3 https://www.roadsidepooledfund.org/?p=5123	Concrete	Evaluation of reducing barrier deflections through the use of pinning every barrier section on the back-side toe of New York State's New Jersey-shape TCB.
Free-Standing Temporary Barrier https://www.roadsidepooledfund.org/?p=3195	Concrete	F-shape free-standing with pin and loop connection.
Free-Standing Temporary Barrier https://www.roadsidepooledfund.org/?p=2491	Concrete	F-shape free-standing barrier with pin and loop connection.
F-Shape Concrete Traffic Barrier With Quick-Bolt Connection https://www.roadsidepooledfund.org/?p=3207	Concrete	32” high F-shape precast concrete barrier.
Indiana Anchored TCB With Wedge Anchored Studs https://www.roadsidepooledfund.org/?p=4875	Concrete	31” tall Indiana anchored TCB with wedge anchored studs; modified top connection also available.
J-J Hooks Bolt-Down F-Shape Barrier https://www.roadsidepooledfund.org/?p=3191	Concrete	F-shape bolt-down barrier system.
J-J Hooks Bolt-Down F-Shape Barrier for Concrete Surface https://www.roadsidepooledfund.org/?p=5303	Concrete	Test barrier 32” high, section length 20” with J-J Hooks connections and a pinned ground connection.
J-J Hooks MASH Free-Standing Barrier https://www.roadsidepooledfund.org/?p=5722	Concrete	F-shape, precast median TCB with J-J Hooks connections. Each barrier segment is 12’ long, 32” tall and 24” wide at the base, tapering to 9” wide at the top with symmetrical lower and upper slopes on both faces.
J-J Hooks Pin Down F-Shape Barrier https://www.roadsidepooledfund.org/?p=3164	Concrete	F-shape PCB pinned to 2’ deep asphalt pad.
MASH TL-3 Low-Profile T-Shaped Concrete Barrier https://www.roadsidepooledfund.org/?p=5902	Concrete	26” tall, 30’ long barrier segments with a T-shape profile, for a total length of 180’. Adjacent barriers connected with two 26” long, 7/8” diameter B7 threaded rods, along with plate washers, SAE hardened washers and Grade 5 hex nuts. The barriers are 15” wide at bottom, 25” wide at top.
New Jersey’s PCB With a Back-Side Pinned Configuration and Grouted Toes https://www.roadsidepooledfund.org/?p=6005	Concrete	32” tall, 20’ long New Jersey DOT PCB with a back-side pinned configuration and grouted toes, connected using connection key.
New Jersey’s PCB With a Bolted Configuration and Grouted Toes https://www.roadsidepooledfund.org/?p=5986	Concrete	32” tall, 20’ long New Jersey DOT PCB with a bolted configuration and grouted toes, connected using connection key.
New Jersey’s PCB With a Box-Beam Stiffened Configuration and Grouted Toes https://www.roadsidepooledfund.org/?p=5998	Concrete	32” tall, 20’ long New Jersey DOT PCB with a box-beam stiffened configuration and grouted toes, connected using connection key.
New Jersey’s PCB With a Free-Standing Configuration and Grouted Toes https://www.roadsidepooledfund.org/?p=5994	Concrete	32” tall, 20’ long New Jersey DOT PCB with a free-standing configuration and grouted toes, connected using connection key.
New Jersey’s PCB With a Free-Standing Configuration https://www.roadsidepooledfund.org/?p=5990	Concrete	32” tall, 20’ long New Jersey DOT PCB with a free-standing configuration, connected using connection key.

Product Name/Link for Further Details	Material	Description
New Jersey's PCB with a Pinned Configuration and Grouted Toes https://www.roadsidepooledfund.org/?p=5982	Concrete	32" tall, 20' long New Jersey DOT PCB with a pinned configuration and grouted toes, connected using connection key.
New Jersey's PCB With a Traffic-Side Pinned Configuration and Grouted Toes https://www.roadsidepooledfund.org/?p=6010	Concrete	32" tall, 20' long New Jersey DOT PCB with a traffic-side pinned configuration and grouted toes, connected using connection key.
Pinned-Down F-Shape TCB on Asphalt https://www.roadsidepooledfund.org/?p=2490	Concrete	Segments connected using pin-and-loop connections and placed adjacent to a 1.5H:1V slope.
PCB Deflection Reducing Retrofit https://www.roadsidepooledfund.org/?p=3588	Concrete	J-J Hooks TCB with retrofit.
Precast Single Slope Concrete Barrier for Bridge and Median Application https://www.roadsidepooledfund.org/?p=5190	Concrete	Restrained 42" single slope concrete barrier with X-bolt on a 7" concrete bridge deck.
Retrofit TL-3 F-Shape PCB (Massachusetts DOT) https://www.roadsidepooledfund.org/?p=5173	Concrete	Retrofit 32" TL-3 F-shape PCB.
Retrofit, Low-Deflection PCB Version 1 https://www.roadsidepooledfund.org/?p=4965	Concrete	32" tall, 12.5' long section length; low-deflection PCB.
Retrofit, Low-Deflection PCB Version 1 https://www.roadsidepooledfund.org/?p=3589	Concrete	Stiffened TCB.
Retrofit, Low-Deflection PCB Version 2 https://www.roadsidepooledfund.org/?p=3590	Concrete	Modified 32" tall, 12.5' long section length, low-deflection TCB.
TL-2 F-Shape PCB (Massachusetts DOT) https://www.roadsidepooledfund.org/?p=5170	Concrete	32" TL-2 F-shape PCB.
TL-3 Upstream Anchorage for F-Shape Temporary Concrete Barrier https://www.roadsidepooledfund.org/?p=3587	Concrete	Precast Kansas F-shape barrier.
TxDOT 32" F-Shape Concrete Barrier Pinned to Concrete Pavement https://www.roadsidepooledfund.org/?p=5315	Concrete	Four standard F-shape type restrained 32" tall median barriers, each nominally 30' in length with J-J Hooks end hook engagements.
RTS Guard https://www.roadsidepooledfund.org/?p=5718	Concrete or steel	Composed of a polyethylene segment measuring approximately 11 3/8" (0.3 m) wide, 35 1/2" (0.9 m) long and 10 3/16" (0.3 m) tall. The segment is fastened to the tops of concrete or steel barriers using concrete anchors or hardware.
18" Wide QuickChange Moveable Barrier Concrete Reactive Tension System https://www.roadsidepooledfund.org/?p=4450	Steel	39" long, 18" wide barrier segments. Steel variable length barriers are used in conjunction with the concrete segments.
BarrierGuard 800 https://www.roadsidepooledfund.org/?p=6238	Steel	Steel barrier formed from a two-step profile; thin gauge sheets of steel welded together form a long hollow section.
BarrierGuard 800 MASH TL-3 Standard https://www.roadsidepooledfund.org/?p=5728	Steel	Barrier is 0.80 m (31.5") high and 0.54 m (21.3") wide without anchor units or 0.70 m (27.6") with anchor units. Weight is approximately 90 kg/m (620 lbs/ft). Sections are joined by linking them together and applying one security bolt per section to keep the

Product Name/Link for Further Details	Material	Description
		sections securely fastened. If desired, two or three sections can remain connected permanently to form 12.0 m (472”) or 18.0 m (709”) combined sections for quicker placement on the road.
BarrierGuard 800 MASH TL-3 Standard Minimum Deflection https://www.roadsidepooledfund.org/?p=5725	Steel	Barrier is 0.80 m (31.5”) high (0.916 m (3’) including hop) and 0.54 m (21.3”) wide without anchor units or 0.70 m (27.6”) with anchor units. The weight is approximately 126 kg/m (84 lbs/ft).
Defender Barrier 100 FS https://www.roadsidepooledfund.org/?p=5715	Steel	Unanchored TL-3 longitudinal steel temporary barrier. Each barrier measures 3,960 mm (155.9”) long x 800 mm (31.4”) high x 680 mm (26.7”) wide and has a dry weight of 320 kg (705.61 lbs).
Defender Barrier 70 https://www.roadsidepooledfund.org/?p=5699	Steel	Unanchored TL-2 longitudinal steel temporary barrier system. Each barrier measures 3,960 mm (155.9”) long x 800 mm (31.4”) high x 680 mm (26.7”) wide and has a dry weight of 320 kg (705.6 lbs).
HV2 Barrier https://www.roadsidepooledfund.org/?p=5965	Steel	Free-standing barrier designed and tested at TL-4 and TL-3 impact speeds, and can be used for lower speed applications. Each barrier section is 5.8 m in length connected with proprietary dual finger-and-knuckle connector welded into the ends.
Mobile Barrier Trailer https://www.roadsidepooledfund.org/?p=3585	Steel	Extended, mobile longitudinal barrier that provides a physical and visual wall.
QuickChange Moveable Barrier Steel Reactive Tension System https://www.roadsidepooledfund.org/?p=5639	Steel	Unanchored longitudinal barrier capable of rapid lateral transfer by a transfer vehicle. Designed to meet the rigid requirements of deployment in movable barrier applications where positive separation is required and where lane widths and lateral space are limited.
SafeZone MASH TL-3 Limited Deflection https://www.roadsidepooledfund.org/?p=5447	Steel	Proprietary modular high-containment and low-deflection steel barrier developed by Laura Metaal Road Safety. Designed for both permanent and temporary use in construction and roadwork applications.
SafeZone MASH TL-4 Limited Deflection https://www.roadsidepooledfund.org/?p=5712	Steel	Barrier is 0.81 m (32”) high and 0.45 m (18”) wide without anchor units or 0.64 m (25”) with anchor units. The weight is approximately 93 kg/m (621 lbs/ft). Designed for both permanent and temporary use in construction and roadwork applications.
Zoneguard (Asphalt) https://www.roadsidepooledfund.org/?p=3697	Steel	Anchored in asphalt every 50’ 0”.
Zoneguard (Concrete) https://www.roadsidepooledfund.org/?p=3584	Steel	Anchored in concrete at ends.
Zoneguard (Standard and Minimum Deflection Arrangements) https://www.roadsidepooledfund.org/?p=3583	Steel	Anchored in concrete every 33’ 4” and at ends.
MASH TrafFix Water Wall https://www.roadsidepooledfund.org/?p=5294	Water-Filled	Longitudinal barrier designed to contain, redirect and shield vehicles from roadside obstacles while providing positive protection and separation between the traveling public and the personnel in the work zone.

Related Research and Resources

A limited literature search of recent publicly available resources identified publications that are organized into the following topic areas:

- National research and practices.
- State research and practices.
- Midwest Roadside Safety Facility research.
- Other related research.

National Research and Practices

New Project: Determination of Encroachment Conditions in Work Zones, NCHRP Project 03-134, start date: June 2019, completion date: December 2021.
Project description at: https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4547
From the project description: More data is needed to identify areas for improvement in the design of work zones and the safety barriers used therein to improve safety in work zones for the traveling public and highway workers. If encroachments for work zones are different than nonwork zones, designers will be able to balance the use of temporary features and optimize the use of public funds by using less expensive barriers. This research is needed to support updates to the Manual for Assessing Safety Hardware (MASH), the Roadside Design Guide (RDG) and the Manual for Uniform Traffic Control Devices (MUTCD).

The objective of this research is to evaluate work zone encroachments and develop guidance to improve safety for workers and the traveling public in roadway work zones. The guidance should address all aspects of work zones from planning (including when to use positive protection) through implementation, and be useable by any entity involved in the life cycle of the work zone.

Guidelines for Work Zone Designers—Positive Protection, William Bremer, John W. Shaw, Madhav V. Chitturi, Andrea Bill and David A. Noyce, Federal Highway Administration, May 2019.
https://www.workzonesafety.org/files/documents/training/fhwa_wz_grant/uw_wz_designer_guidelines_positive_protection-n-508.pdf
From the introduction:

> This document provides information to help guide decisions about when to use positive protection and what type of positive protection to specify. It includes an introduction to the topic of work zone positive protection, describes various types of temporary barrier systems and accessories currently approved for use in the United States, and provides a framework for the barrier selection process.

Chapter 3 describes various types of barrier systems, including temporary portable concrete barriers, portable steel barriers and movable barriers (beginning on page 28 of the report, page 34 of the PDF).

NCHRP Project 22-36: Synthesis of the Performance of Portable Concrete Barrier Systems, Preliminary Draft Final Report, Chiara Silvestri-Dobrovolny, Shengyi Shi, Andrew Brennan, Roger Bligh and Nauman Sheikh, National Cooperative Highway Research Program, March 2019.
http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP22-36DraftReport-2019-03-08.pdf
From the executive summary: Under this project, research was performed to (a) synthesize information on the performance of existing or under-development non-proprietary portable concrete barrier [PCB] systems, and (b) propose recommendations for future research needs to improve the performance of PCB systems. The research approach included collecting relevant literature and current practices to determine the current state of knowledge of PCB and associated components and systems, conducting a survey to identify the most commonly used PCB systems and their desired/needed improvements, outlining perceived advantages and disadvantages of each PCB system, and proposing recommendations for future research needs.

It is known that the impact performance of PCBs is influenced by a number of variables, which include barrier shape/profile, barrier height, segment length, joint rotation slack, joint moment capacity, joint tensile strength and barrier-roadway friction. In order to identify the most commonly used PCB systems and perceive their needed improvements, a survey of state departments of transportation (DOTs) was completed.

Manual for Assessing Safety Hardware, Second Edition, American Association of State Highway and Transportation Officials, 2016.
Table of contents and Chapter 1 available at
https://store.transportation.org/Common/DownloadContentFiles?id=1539
From the introduction: The purpose of this manual is to present uniform guidelines for the crash testing of both permanent and temporary highway safety features and recommended evaluation criteria to assess test results. Guidelines are also presented for the in-service evaluation of safety features. These guidelines and criteria, which have evolved over the past 40 years, incorporate current technology and the collective judgment and expertise of professionals in the field of roadside safety design. They provide: (1) a basis on which researchers and user agencies can compare the impact performance merits of candidate safety features, (2) guidance for developers of new safety features, and (3) a basis on which user agencies can formulate performance specifications for safety features.

Guidance: Use of Work Zone Clear Zones, Buffer Spaces and Positive Protection Deflection Distances, Work Zone Safety Consortium, Federal Highway Administration, May 2014.
https://www.workzonesafety.org/files/documents/training/courses_programs/rsa_program/RSP_Guidance_Documents_Download/RSP_Clear_Zones_Guidance.pdf
From the objectives: This document summarizes available guidance on the use of work zone clear zones, buffer spaces and positive protection deflection distances. The purpose of this document is to help work zone designers and workers understand:

- The role of separation distances and positive protection device deflection distances in safety for workers and motorists and
- How properly to install, maintain and use these methods in various types of work zones.

Roadside Design Guide, Fourth Edition, American Association of State Highway and Transportation Officials, 2011.
Publication available at https://store.transportation.org/Item/CollectionDetail?ID=105
Chapter 9 of this guide addresses traffic barriers, traffic control devices and other safety features for work zones.

NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features, H. E. Ross Jr., D. L. Sicking, R. A. Zimmer and J. D. Michie, 1993.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_350-a.pdf
From the foreword: This report is recommended to highway design engineers, bridge engineers, safety engineers, maintenance engineers, researchers, hardware developers and others concerned with safety features used in the highway environment. It contains recommended procedures for evaluating the safety performance of various highway safety features. These procedures are based on a comprehensive literature review, an analysis of the state of the art for performance evaluation (including procedures adopted by foreign agencies), and the advice of a selected group of acknowledged experts.

State Research and Practices

Florida

Temporary Barrier Inspection Training, Daniel Strickland and Olivia Townsend, Office of Construction, Florida Department of Transportation, undated.
https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/construction/construction/engineers/mot/presents/barrier-wall.pdf?sfvrsn=c0076997_0
Types of temporary barriers—concrete, steel and water-filled—and installation practices are discussed beginning with slide 24.

Georgia

Design Policy Manual, Georgia Department of Transportation, October 2019.
http://www.dot.ga.gov/PartnerSmart/DesignManuals/DesignPolicy/GDOT-DPM.pdf
A discussion of temporary barriers begins on page 126 of the PDF.

Minnesota

Use of Positive Protection in Work Zones, Minnesota Department of Transportation, May 2017.
http://dot.state.mn.us/research/TRS/2017/TRS1703.pdf
From the introduction: The MnDOT [Minnesota Department of Transportation] Office of Traffic, Safety and Technology is developing a manual on the use of temporary barriers, truck-mounted attenuators and other types of positive protection devices as guidance to be used by designers, construction workers and contractors. To support the development of this manual, MnDOT is interested in gathering information on best practices for positive protection in work zones used by other state departments of transportation (DOTs). To help with this task, an online survey was distributed to members of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction about their DOTs' policies and practices for positive protection in work zones. A literature search was also conducted, with a focus on obtaining links to positive protection manuals, guidance and specifications from other DOTs.

Montana

Portable Concrete Barrier Condition and Transition Plan Synthesis, Final Report, David Veneziano and Yongxin Li, Montana Department of Transportation, June 2012.
https://www.mdt.mt.gov/other/webdata/external/research/docs/research_proj/cmb/final_report.pdf
From the abstract: This report presents a synthesis of information from past published research and reports, as well as information from a survey of transportation agencies conducted as part of this project, regarding precast concrete barriers, the corrosion of their connection systems, approaches to rating/ranking this corrosion, and current state DOT practices for their maintenance and replacement. Potential strategies for prioritizing barrier replacement are identified and discussed.

New York

Chapter 16, Maintenance and Protection of Traffic in Highway Work Zones, Highway Design Manual, New York State Department of Transportation, April 2017.
https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_16.pdf
A discussion of temporary traffic barriers begins on page 49 of the PDF.

Ohio

Approved Temporary Barrier, Roadway Standards, Roadway Engineering, Ohio Department of Transportation, undated.
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/TemporaryBarriers.aspx
This web page provides information and design drawings for the following products that may be used as equivalents to Ohio DOT's generic PCBs:

- J-J Hooks PCB.
- Zoneguard steel traffic barrier.
- Vulcan barrier—portable steel longitudinal barrier.
- Movable barrier.
- Temporary narrow barrier.

Oregon

Evaluation of a Mobile Work Zone Barrier System, Final Report, John A. Gambatese and Nicholas Tymvios, Oregon Department of Transportation, August 2013.
https://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR746_MobileBarriers.pdf
From the abstract: A recent advancement in work zone safety is a mobile barrier system that consists of a motorized tractor/trailer combination, and can provide complete isolation of the work area for a distance of up to 100 feet. The research presented in this report involved evaluating a mobile barrier in a variety of work zone environments, leading to a determination of its benefits and limitations to guide ODOT [Oregon Department of Transportation] in future work zone safety strategies/investments. A benefit of using a mobile barrier system is the added safety provided by the isolation of workers from errant vehicles. Anticipated benefits also include: improved efficiency of work zone setup and removal; improved efficiency of the work activity as the mobile barrier can be equipped with lights, generators, variable message signs, and TMAs; and improved mobility of the work zone where multiple finite work areas are involved.

Texas

MASH TL-3 Evaluation of the TxDOT TL-3 Low-Profile Barrier for High Speed Applications, Chiara Silvestri Dobrovolny, Shengyi Shi, Roger P. Bligh, Wanda L. Menges and Darrell L. Kuhn, Texas Department of Transportation, September 2018.
https://static.tti.tamu.edu/tti.tamu.edu/documents/0-6968-R1.pdf
From the abstract: [T]he Texas Department of Transportation Bridge, Design, Maintenance and Traffic Operations Divisions reviewed their standards for roadside safety devices and identified those devices that require testing and evaluation to assess MASH compliance. Under this phase of the project, the Low-Profile Concrete Barrier (LPCB-13) was evaluated. The objective of this project was to design a TL-3 low-profile barrier for high speed applications and assess its performance according to the safety-performance evaluation guidelines included in MASH for Test Level 3 (TL-3) longitudinal barriers. Based on the detailed computer model simulations results, researchers performed MASH full-scale crash tests on a low-profile portable concrete barrier system comprised of 26-inch tall, 30-[foot] long barrier segments with a T-shape profile. Based on constructability feedback, researchers modified the straight side of the barrier to a 1:18 slope, to allow for easiness of construction forming. The TL-3 Low-Profile Barrier performed acceptably as a MASH TL-3 longitudinal barrier.

Virginia

Roadside Safety Devices, Location and Design Division, Virginia Department of Transportation, undated.
https://www.virginiadot.org/business/locdes/nchrp350-index.asp
Eligible roadside safety hardware, including roadway concrete barriers (temporary and permanent) and steel barriers (temporary) as an alternative to temporary concrete barriers, is addressed on this web page. Also included are links to the agency's NCHRP-approved products, provisionally approved MASH products and FHWA roadway safety feature information. *From the web site*:

> VDOT [Virginia DOT] requires all roadside safety hardware to have completed crash testing at an approved ISO 17025 laboratory when installed within VDOT right of way. Crash testing will be done in accordance with the American Association of State Highway [and] Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH 2016).

Virginia Work Area Protection Manual: Standards and Guidelines for Temporary Traffic Control, Virginia Department of Transportation, April 2015.
http://www.virginiadot.org/business/resources/const/2011_WAPM_Rev_1_Print.pdf
Temporary barriers are discussed in Section 6F.94 (beginning on page 134 of the PDF) and Appendix A (beginning on page 333 of the PDF).

Midwest Roadside Safety Facility Research

The research cited below was performed by the Midwest Roadside Safety Facility, a "research organization with a main focus of researching all aspects of highway design and safety." The facility has been accredited to conduct safety performance evaluations that include vehicle testing of crash barriers.

Two links are provided for each research project cited below. The first link is for the final report; the second is for related materials that may include drawings and videos.

Development of a Retrofit, Low-Deflection, Temporary Concrete Barrier System, Robert W. Bielenberg, Ronald K. Faller, Tyson E. Quinn, Dean L. Sicking and John D. Reid, Midwest States Regional Pooled Fund Program, March 2014.
Final report: https://mwrsf.unl.edu/researchhub/files/Report287/TRP-03-295-14.pdf
Related materials: https://mwrsf.unl.edu/reportResult.php?reportId=287&search-textbox=temporary%20barrier
From the abstract: The objective of this research effort was to develop a stiffening mechanism for use in reducing the deflection of temporary concrete barrier (TCB) installations without requiring anchorage of the barrier segments to the road surface. The joint-stiffening mechanism was developed for use with the Midwest Pooled Fund States' 12.5-ft (3.8-m) long, F-shape, temporary concrete barrier.

The research effort included development and analysis of mechanisms for limiting deflections through engineering analysis and LS-DYNA computer simulation. Following analysis of the candidate designs, an initial prototype design was full-scale crash tested. Following the first full-scale crash test, the low-deflection TCB system was modified to further reduce deflections and full-scale crash tested a second time. The final version of the low-deflection TCB system was capable of reducing dynamic barrier deflections almost 50% over free-standing TCB installations while still safely redirecting errant vehicles

Dynamic Evaluation of a Pinned Anchoring System for New York State's Temporary Concrete Barriers—Phase II, Karla A. Lechtenberg, John D. Reid, Ronald K. Faller and Dean L. Sicking, New York State Department of Transportation, January 2010.
Final report: https://mwrsf.unl.edu/researchhub/files/Report59/TRP-03-224-10.pdf
Related materials: https://mwrsf.unl.edu/reportResult.php?reportId=59&search-textbox=temporary%20barrier.
From the abstract: Temporary concrete barrier (TCB) systems are utilized in many situations, including placement adjacent to vertical drop-offs. Free-standing TCB systems are known to have relatively large deflections when impacted, which may be undesirable when dealing with limited space behind the barrier, such as on a bridge deck or with limited lane width in front of the barrier system. … The primary research objectives were to evaluate the potential for reducing barrier deflections through the use of pinning every barrier section on the back-side toe of the New York State's New Jersey-shape TCBs and evaluate the barrier system according to the Test Level 3 (TL-3) criteria set forth in the Manual for Assessing Safety Hardware (MASH).

Termination and Anchorage of Temporary Concrete Barriers, Scott K. Rosenbaugh, Robert W. Bielenberg, Ronald K. Faller, John D. Reid, John R. Rohde, Dean L. Sicking, Karla A. Lechtenberg and James C. Holloway, Midwest States Regional Pooled Fund Program, October 2009.
Final report: https://mwrsf.unl.edu/researchhub/files/Report63/TRP-03-209-09.pdf
Related materials: https://mwrsf.unl.edu/reportResult.php?reportId=63&search-textbox=temporary%20barrier
From the abstract: Free-standing temporary barrier designs have been used on our nation's highways for many years. Traditionally, these types of barriers have been designed and tested based solely on impacts in the middle of the barrier system or at the Length-Of-Need (LON). Historically, the assumption has been made that a crashworthy barrier system would perform adequately regardless of where it was impacted along the system length. However, it is believed that impacts closer to the system ends would very likely increase barrier deflections and may result in pocketing, vehicle climb and/or vehicle instabilities, such as rollovers.

This research study developed a termination anchorage for an F-shape temporary concrete barrier system that shortened the beginning of the LON for the system to the first barrier segment. The system was designed for use specifically with the Kansas F-shape temporary concrete barrier. The termination anchorage provided sufficient constraint to redirect vehicles impacting on the first barrier segment in the system, reduced vertical rotation of the end barrier segment to improve vehicle stability, used previously developed anchorage hardware, and could be attached to either end of the temporary barrier segment when placed on the upstream end of the system.

Other Related Research

"Development of a Precast Slim Temporary Concrete Safety Barrier STCSB 50 for Work Zone Applications," Ali Osman Atahan, Turan Arslan, Wolfgang Ganster and Thomas Edl, *Journal of Transportation Safety and Security*, Vol. 11, No. 3, pages 287-304, May 2019.
Citation at https://www.tandfonline.com/doi/full/10.1080/19439962.2017.1402837
From the abstract: This article summarizes performance requirements and development details of a precast slim temporary concrete safety barrier, slim temporary concrete safety barrier (STCSB 50), mainly utilized to guide the traffic flow and safely divide lanes on motorways. Having 50 cm in height with a width of only 24 cm at the base and 12 cm throughout its height makes STCSB 50 a very narrow and low-profile work zone barrier. The design was crash tested according to EN1317 requirements [the European standard for road safety product certification], and its performance clearly demonstrated its robustness as a state of the art safety barrier for work zone applications.

"Development of a Test Level 3 Transition Between Guardrail and Portable Concrete Barriers," Robert W. Bielenberg, David Gutierrez, Ronald K. Faller, John D. Reid and Phil Tenhulzen, *Transportation Research Record 2638*, pages 77-87, January 2017.
Citation at https://journals.sagepub.com/doi/abs/10.3141/2638-09
From the abstract: A study was done to develop a crashworthy transition between W-beam guardrail and PCB systems. Design concepts were developed and refined through computer simulation with LS-DYNA. Additionally, a study of critical impact points was conducted to determine impact locations for full-scale crash testing. The design effort resulted in a new system consisting of a Midwest Guardrail System that overlapped a series of F-shape PCB segments placed at a 15:1 flare. In the overlapped region of the barrier systems, uniquely designed blockout supports and a specialized W-beam end shoe mounting bracket were used to connect the systems. Three full-scale vehicle crash tests were successfully conducted according to the Manual for Assessing Safety Hardware Test Level 3 safety performance criteria. Because of the successful test results, a Test Level 3 crashworthy guardrail-to-PCB transition system is now available for protecting motorists, workers and equipment in work zones.

Contacts

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Appendix A: Survey Questions

The following surveys were distributed to state departments of transportation (DOTs) and vendors expected to have experience with temporary construction barriers.

State DOT Survey

The following survey was distributed to state DOT members of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Traffic Engineering.

Caltrans Survey on Safe and Sustainable Temporary Construction Barriers

1. Please provide a brief description of your agency's policy regarding the selection of temporary construction barriers, including how determinations are made to use metal or concrete.
2. Please describe how climate and climate zones affect your agency's selection of temporary construction barriers.
3. How many temporary construction barrier systems has your agency adopted for use?
    - 1
    - 2
    - 3
    - 4
    - More than 4
4. If available, please provide links to documentation that describes your agency's policies and practices for selecting, installing and maintaining temporary construction barriers. Send any files not available online to carol.rolland@ctcandassociates.com.

Temporary Construction Barrier Descriptions

The next sections of the survey asked respondents to describe the temporary construction barrier systems their agencies use. The survey offered the opportunity to describe three different systems. If an agency uses more than three temporary construction barrier systems, respondents were asked to describe the **three most frequently used** systems.

Temporary Construction Barrier System 1

System Description

1. What is the system name?
2. What is the name of the vendor providing the system?
3. Approximately how many projects have used this type of barrier?
4. Does the system meet Manual for Assessing Safety Hardware (MASH) requirements?
    - Yes
    - MASH approval is pending
    - No
5. What is the material used in the system? Select the best option.
    - Concrete
    - Metal

- Combination of metal and concrete
- Water-ballasted plastic
- Water-ballasted plastic with internal steel frame
- Water-ballasted plastic with external steel frame
- Other (please describe)

6. Is it a pinned or free-standing system?
    - Pinned
    - Free-standing
7. What is the **length** of each "stick" of the system? Please describe all "stick" lengths if the system includes more than one size.
8. What is the **width** of each "stick" of the system? Please describe all "stick" widths if the system includes more than one size.
9. What does a single "stick" of the system **weigh**? Please describe all "stick" weights if the system includes more than one size.
10. What is the system's reported maximum dynamic deflection distance?

Transporting the System

1. What type of equipment is used or needed to load and unload the "sticks"?
2. Is the system stackable?
    - Yes
    - No
3. How many "sticks" can be loaded in a single truckload?
4. Please rate the **ease of transporting** the system by selecting the best option below.
    - Extremely easy to transport
    - Very easy to transport
    - Somewhat easy to transport
    - Not so easy to transport
    - Not at all easy to transport

Constructing and Maintaining the System

1. Please rate the system's **ease of constructability** by selecting the best option below.
    - Extremely easy to construct
    - Very easy to construct
    - Somewhat easy to construct
    - Not so easy to construct
    - Not at all easy to construct
2. Please rate the system's **speed of constructability** by selecting the best option below.
    - Extremely fast to construct
    - Very fast to construct
    - Somewhat fast to construct
    - Not so fast to construct
    - Not at all fast to construct

3. Can the system be repaired and maintained on-site?
    - Yes
    - No
4. Please describe the **typical types of repairs** your agency has made to the system.
5. Please describe **typical maintenance** for the system, including the maintenance schedule and the types of maintenance your crews complete.
6. Can a complete inspection of the system be conducted on-site without dismantling the system?
    - Yes
    - No (please describe how an inspection is conducted)

Life Expectancy

1. What is the estimated life expectancy of the system?
2. Please describe the recycle and disposal options when the system's useful life has ended.

Other Barrier Types

Our agency uses a second/third temporary construction barrier system.

- Yes (skips the respondent to **Temporary Construction Barrier System 2/Temporary Construction Barrier System 3** questions)
- No (skips the respondent to the **Wrap-Up** section)

Note: In the online survey, the question blocks presented above for **Temporary Construction Barrier 1** were repeated for Temporary Construction Barrier System 2 and Temporary Construction Barrier System 3. Respondents providing information for all three sets of barrier questions were directed to the **Wrap-Up** section after responding to the questions under Temporary Construction Barrier System 3.

Wrap-Up

Please use this space to provide any comments or additional information about your previous responses.

Barrier Vendor Survey

The following survey was distributed to four temporary construction barrier vendors recommended by the Caltrans project panel:

- Hill and Smith, Inc.
- Rockingham Precast, Inc.
- Safe Barriers North America LLC.
- Saferoads.

Caltrans Survey on Safe and Sustainable Temporary Construction Barriers

1. How many types of temporary construction barriers does your firm offer?
    - 1
    - 2
    - 3
    - 4
    - More than 4
2. Please describe how climate and climate zones affect your firm's recommendations for the type of temporary construction barrier suitable for your clients' use.
3. If available, please provide links to documentation with regard to your firm's temporary construction barriers. Of particular interest are Environmental Product Declarations or other data sheets describing the barrier system(s). Send any files not available online to carol.rolland@ctcandassociates.com.

Temporary Construction Barrier Descriptions

The next sections of the survey asked respondents to describe the temporary construction barrier systems their firms offer. The survey offered the opportunity to describe three different systems. If a firm offered more than three temporary construction barrier systems, respondents were asked to describe the **three most frequently used** systems.

Temporary Construction Barrier System 1

System Description

1. What is the system name?
2. Does the system meet Manual for Assessing Safety Hardware (MASH) requirements?
    - Yes
    - MASH approval is pending
    - No
3. What is the material used in the system? Select the best option.
    - Concrete
    - Metal
    - Combination of metal and concrete
    - Water-ballasted plastic
    - Water-ballasted plastic with internal steel frame
    - Water-ballasted plastic with external steel frame
    - Other (please describe)
4. Is it a pinned or free-standing system?
    - Pinned
    - Free-standing
5. What is the **length** of each "stick" of the system? Please describe all "stick" lengths if the system includes more than one size.
6. What is the **width** of each "stick" of the system? Please describe all "stick" widths if the system includes more than one size.

7. What does a single “stick” of the system **weigh**? Please describe all “stick” weights if the system includes more than one size.
8. What is the system’s reported maximum dynamic deflection distance?

Environmental Considerations

1. Has your firm identified the environmental impact of the production process used to manufacture this system?
    - No
    - Yes (please describe these impacts)
2. Does your MASH-approved barrier or its material components have any available Environmental Product Declarations (EPDs) (i.e., if not for the final product then for any rebar, concrete, plastic or steel subcomponents, etc.)?
    - No
    - Yes (please provide links to the EPD(s) or send any files not available online to carol.rolland@ctcandassociates.com)
3. Has your firm documented sustainability benefits for your product related to life cycle assessment (LCA), life cycle cost assessment (LCCA), sources of raw materials, energy consumption in manufacturing, or recycled and recyclable content?
    - No
    - Yes (please briefly describe these sustainability benefits; provide links to documentation or send any files not available online to carol.rolland@ctcandassociates.com)

Transporting the System

1. What type of equipment is used or needed to load and unload the “sticks”?
2. Is the system stackable?
    - Yes
    - No
3. How many “sticks” can a client expect to include in a single truckload?

Constructing and Maintaining the System

1. Can the system be repaired and maintained on-site?
    - Yes
    - No
2. Please describe the **typical types of repairs** your clients can expect to perform on the system.
3. Please describe **typical maintenance** for the system, including the maintenance schedule and the types of maintenance crews can expect to complete.
4. Can a complete inspection of the system be conducted on-site without dismantling the system?
    - Yes
    - No (please describe how an inspection can be conducted)

Life Expectancy

1. What is the estimated life expectancy of the system?
2. Please describe the recycle and disposal options when the system's useful life has ended.

Other Barrier Types

Our firm offers a second/third temporary construction barrier system.

- Yes (skips the respondent to **Temporary Construction Barrier System 2/Temporary Construction Barrier System 3** questions)
- No (skips the respondent to the **Wrap-Up** section)

Note: In the online survey, the question blocks presented above for **Temporary Construction Barrier 1** were repeated for Temporary Construction Barrier System 2 and Temporary Construction Barrier System 3. Respondents providing information for all three sets of barrier questions were directed to the **Wrap-Up** section after responding to the questions under Temporary Construction Barrier System 3.

Wrap-Up

Please use this space to provide any comments or additional information about your previous responses.