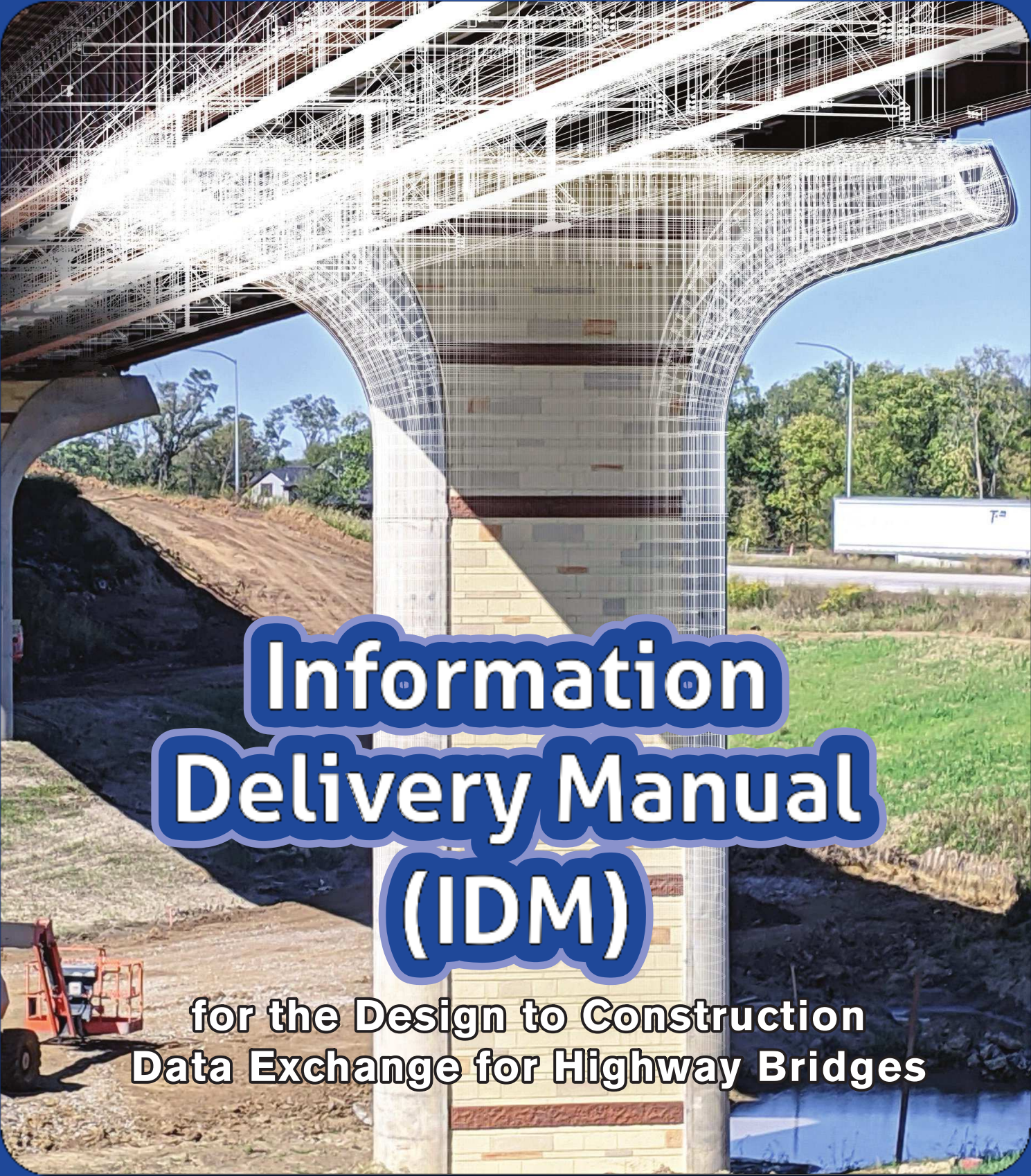


FIRST EDITION



Information Delivery Manual (IDM)

**for the Design to Construction
Data Exchange for Highway Bridges**

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LIST OF ACRONYMS

ACI—
AISC—American Institute of Steel Construction
BIM—Building Information Modeling
CBS—Committee on Bridges and Structures
CM/GC—Construction Manager/General Contractor
FEA—Finite Element Analysis
FHWA—Federal Highway Administration
GUID—Globally Unique Identifier
IDM—Information Delivery Manual
IFC—Industry Foundation Classes
MVD—Model View Definition
NSBA—National Steel Bridge Alliance
PCI—Precast/Prestressed Concrete Institute
RFI—Request for Information
TG—Task Group
TPF—Transportation Pooled Fund
U.S.—United States

EXECUTIVE SUMMARY

This Information Delivery Manual (IDM) provides a human-readable set of information requirements for the exchange of model-based information to execute the construction of highway bridges in the United States (U.S.). There are subtasks that are supported, including preparing a bid package and initiating the fabrication phase.

The exchange supported by this IDM is the Owner's provision of model-based information in the bidding and letting phase of a bridge project. The recipient of the construction contract model is the Contractor, who passes the information through to the Fabricator and Detailer. The scope of the exchange requirement includes "workhorse"-type bridges and other structures, such as slab bridges, girder bridges, common buried structures (i.e. box culverts, three-sided structures, arches), and retaining walls associated with or adjacent to a bridge. The exchange requirements were developed for design-bid-build delivery of full replacement and new build bridges and structures.

This IDM presents a human-readable list of U.S. bridge and structure entities, property sets, and properties, determined by U.S. bridge and structure domain experts. Entities are grouped into categories (e.g., project identification information) or systems (e.g., bridge superstructure). This IDM outlines the technical process and requires data to be exchanged between the Owner and bridge construction Contractor in the U.S. The intent is that this model data be passed through to the Fabricator and Detailer to begin their processes.

It should be noted that a "model-based exchange" is not limited to graphical entities explicitly modeled in three dimensions, but should be construed as a data set including graphical entities along with information attached to the modeled entities. For example, notes and tabular information required for construction and fabrication are anticipated to be included in a model-based exchange. Nevertheless, some contractual documents in the bidding and letting phase are anticipated to be provided to the Contractor outside of the model-based exchange, which is designated as the "non-model-based exchange." Non-model-based exchanges are not included in this IDM.

The authors of this IDM anticipate that a Model View Definition (MVD) will be created using the IDM, enabling the interoperable exchange of supported bridge and structure information using Version 4.3 of the Industry Foundation Classes (IFC) schema.¹ The resulting MVD would enable software developers to implement consistent and accurate exchanges of the exchange requirement contained in this IDM within their applications. This would fulfill the primary objective of this IDM.

¹ At the time of writing, IFC 4.3 was a candidate standard and still in active development. For more information, refer to the buildingSMART International page that tracks IFC versions: <https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/>

ACKNOWLEDGEMENTS

The authors acknowledge that this IDM built on preceding work by the AASHTO/NSBA Steel Bridge Collaboration Task Group 15. In particular, this IDM built upon information summarized in the draft document, “Information Delivery Manual for Steel Bridge Detailing for Fabrication Part 1: Industry Use Narrative” from 2021. This included a process map, an initial exchange requirement for steel fabrication, and definitions of terms. The authors of this IDM adopted and built upon the efforts of Task Group 15 and shared the outcomes with Task Group 15 so that continuing work by Task Group 15 is in harmony with this IDM.

The IFC (Industry Foundation Classes) Standard is a community standard developed, managed, and owned by buildingSMART International. The IFC 4.3 standard is the copyright © 2022 of buildingSMART International. All rights reserved. It is licensed under Creative Commons BY ND 4.0 license. For more information, please refer to the IFC Specifications Database at <https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/>.

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INTRODUCTION

This Section provides an orientation to this Information Delivery Manual. It explains the purpose and organization of the IDM; the target audience of the IDM; the IDM's provenance; and how to use the IDM.

1.1—PURPOSE

The United States (U.S.) highway bridge community desires increased interoperability of digital design data. Specifically, the primary interest is in providing repeatable, reliable, and systematic exchange of design information for use in construction applications. An Information Delivery Manual (IDM) is a core element of building a solution for interoperability. An IDM defines the requirements to fulfill a specific digital information exchange.

This IDM is associated with a specific business use case that is part of the overarching lifecycle of the bridge or structure. The business use case is documented on a process map that identifies the exchange of information. The purpose of the IDM is to define and characterize the information that is required for that exchange to effectively execute the business use case. This IDM provides a human-readable set of information requirements for the exchange of model-based information to execute the construction of highway bridges in the U.S. There are subtasks that are supported, including preparing a bid package and initiating the fabrication phase.

The IDM could support the development of a range of technical solutions for computer-interoperable information exchange. The authors of this IDM intend for this document to support mapping the exchange requirement to Version 4.3 of the Industry Foundation Classes (IFC) schema to develop a Model View Definition (MVD) that can be implemented primarily in commercial off-the-shelf software. An MVD enables software developers to create a mechanism to send and receive bridge information using the open IFC schema, significantly improving the interoperability of bridge models.

1.2—ORGANIZATION

This IDM provides an industry-use narrative to derive the information exchange requirement in a human-readable format. This narrative describes the information needed to support the business use case that the IDM supports. First, the IDM defines the business use case that is supported, including the business processes, phases, and actors involved in the information exchange. Then, the IDM identifies the structure and material types that are included and documents what information is to be delivered. Finally, the IDM provides the information exchange requirement to specify what information to produce (for an initiator of a supported exchange) and what information to expect to receive (for a recipient).

1.3—TARGET AUDIENCE

This IDM is intended for the owners of highway bridges and related structures as well as for design and construction professionals. Specifically:

- **Bridge Owners and design and construction professionals** will be able to determine how highway bridge and structure information is delivered using the IFC format when read or written by software that supports the associated MVD.
- **Bridge Owners' Automation Engineers** (sometimes called Methods Development or Standards Engineers) will be able to set up software workspaces and design standards to support the creation and exchange of the information requirements.

- **Project Information Managers** (sometimes called Building Information Modeling (BIM) Managers) will be able to set up project workspaces to implement the exchange requirement on projects.
- **IFC experts** will use the requirements from this IDM to develop an IFC MVD to be implemented by software developers.
- **Application Developers** may refer to this IDM when implementing the MVD.

1.4—PROVENANCE

The Transportation Pooled Fund (TPF) program is a cooperative program that enables Federal, state, and local transportation agencies and other organizations to combine resources to support transportation research studies. The TPF study for BIM for Bridges and Structures, TPF-5(372), was established in 2017 to provide the primary funding mechanism for the AASHTO Committee on Bridges and Structures (CBS) to perform the duties of governance and stewardship of BIM for bridges and structures. At the time of writing, the FHWA and 24 state highway infrastructure owner agencies fund and actively participate in the TPF-5(372) study.

AASHTO passed a resolution in 2019 adopting IFC as the standard data schema for the exchange of electronic engineering data for AASHTO states (AASHTO, 2019). This IDM document was prepared by the contractor for the TPF-5(372) project under the oversight of the AASHTO CBS, which represents highway bridge and structure owner–operators in the U.S. The authors of this document include bridge and structure domain experts, bridge data scientists, and IFC developers.

Through AASHTO, U.S. highway infrastructure owners cooperate on the standards by which bridges are designed, inspected, and managed. Federal law dictates specific information requirements for bridge inventories and reporting requirements, as well as the procedures for managing federally funded construction. Both regulations create a fruitful ground for standardizing the processes of bridge development and, thereby, the information exchanges. AASHTO and the Federal Highway Administration (FHWA) collaborated over the past decade to develop a high-level process map for highway bridge and structure development (Chen and Shirole, 2013, and Chipman et al, 2016).

In 2016, FHWA published a body of work², based on the IFC schema, which defined the requirements necessary for a machine-to-machine exchange of highway bridge and structure design information for construction. This defining work was based on IFC 4.0 and lacked the full complement of bridge elements that are now available in IFC 4.3. The work added to the body of knowledge that informed the IFC Bridge project (Castaing et al, 2017) to expand the schema in IFC 4.3.

The FHWA and AASHTO formed the TPF-5(372)³, amongst other purposes, to develop an MVD that will support implementation. This IDM is the result of an inclusive approach to systematically define elements and information requirements needed to implement IFC in highway bridge design and construction software for the U.S. market.

1.5—HOW TO USE THIS DOCUMENT

The IDM documents the supported information exchanges in a human-readable narrative. The scope of the information exchanges is described in terms of:

- The business use case for which the exchange is intended;
- The business processes that define the information exchange;
- The specific bridge and structure entities to be exchanged; and
- The specific properties, property sets, and relationships for those entities.

The information is presented as follows:

- Section 2 describes the business use case and business processes that define the information exchange. It culminates in a detailed definition of the exchange supported by this IDM.
- Section 3 describes the specific bridge and material types and appurtenances that are included and excluded from the scope of the IDM.
- Section 4 documents the detailed exchange requirement for the included structure and material types identified in Section 3 to fulfill the business use case identified in Section 2.

1.6—IDM ARTIFACTS

There are several artifacts of an IDM that are required to properly contextualize the exchange (See et al, 2012). These are:

- **Business Use Case:** A description of an industry need including a general description of the workflow, the participants, and the information content and flow necessary to achieve the desired outcome (See et al, 2012).
- **Process Map:** A visual representation and plain language description of the logical and sequential flow of activities and information exchanges described in the business use case (See et al, 2012). The process map may illustrate antecedent and subsequent activities to place the specific supported exchanges into context. This includes the relationships between the activities (processes) to achieve the outcome; the actors involved; and the information required, consumed, and produced.
- **Exchange Requirement:** A defined set of information that needs to be exchanged to support a particular business requirement at a particular process phase (or phases)/stage (or stages) (ISO, 2016). The exchange requirement is the relevant information defined within an information model to fulfil the requirements of an information exchange between two business processes at a particular stage of the project. The data is defined to include geometry and property or attribute data for objects and elements.

The artifacts can be located in the IDM as follows:

- Section 2 contains the business use case and process map.
- Section 3 identifies the scope of the information to be exchanged. It is a high-level list of the bridge and structure and material types included within the scope of the exchange.
- Section 4 contains the exchange requirement in the form of detailed lists.

The authors of this IDM intend that the exchange requirement presented in this IDM will be the input that establishes an MVD. This data will also be added to the buildingSMART Data Dictionary (bSDD). The bSDD is an online service that hosts classifications and their properties, allowed values, units, and translations.

² [IFC Bridge Design to Construction Information Exchange \(U.S.\) IFC 4.1 Model View Definition](#)

³ [Building Information Modeling \(BIM\) for Bridges and Structures TPF-5\(372\)](#)

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BASIS FOR THE EXCHANGE

This Section describes the basis of this IDM. It describes the selected information exchange and the processes by which information is exchanged, which give rise to the information requirements. The objectives of this Section are to:

- Define the specific **business use case** for the information exchange;
- Map and describe the **processes** associated with the business use case, including phases, actors involved, and inputs and outputs; and
- Define the specific **information exchange** supported by this IDM.

2.1—BUSINESS USE CASE

This IDM supports one specific business use case, which is the exchange of model-based information to execute the construction of highway bridges in the U.S. There are subtasks to the business use case that are supported, including preparing the bid package and initiating fabrication.

2.1.1—Provide Design Information to Execute Construction

Construction contract documents consist of a complete set of information sufficient to execute construction. These are typically comprised of plans, specifications, estimated quantities, and other documents that are coordinated by a section of the construction specifications, typically titled “Coordination of Contract Documents.” While construction plans contain graphical information that is often derived from a model, the plans have typically been a document-based exchange. This business use case is a model-based exchange of the graphical information and associated properties that form part of the contract documents. Figure 2.1.1-1 is a process map that identifies the phase in which the owner delivers this complete set of contract documents to the Contractor. This information exchange, i.e. the construction contract model, is shown in green on Figure 2.1.1-1. The construction contract model may replace the document-based plans in whole or in part. Figure 2.1.1-1 shows message- and document-based exchanges between the Owner and the Contractor that may revise the contents of the contract documents throughout the construction process, but the Owner does not deliver any new sets of information.

2.1.1.1—Prepare Bid Package

The schedule of estimated quantities is a primary document for construction bids. The owner provides an estimated schedule of quantities associated with contract pay items. Bidders submit itemized prices for each contract pay item, which form the basis for evaluating bids and subsequently paying the contractor for the work. The core functions of the bidding process are to use the contract documents to take off quantities, develop means and methods, and determine a price to complete the work using the schedule of estimated quantities.

2.1.1.2—Provide Design Information to Initiate the Fabrication Phase

Construction contract documents provide information intended for the Contractor, which includes information about fabricated components that the contractor typically passes through to the Fabricator. The pass-through information is sufficient to initiate the fabrication phase. The Contractor and Fabricator supply additional information needed to execute fabrication. This subtask is a model-based exchange of the graphical information and associated properties specifically related to fabricated components that forms part of the construction contract documents. The design information to initiate the fabrication phase is a subset of the construction contract model.

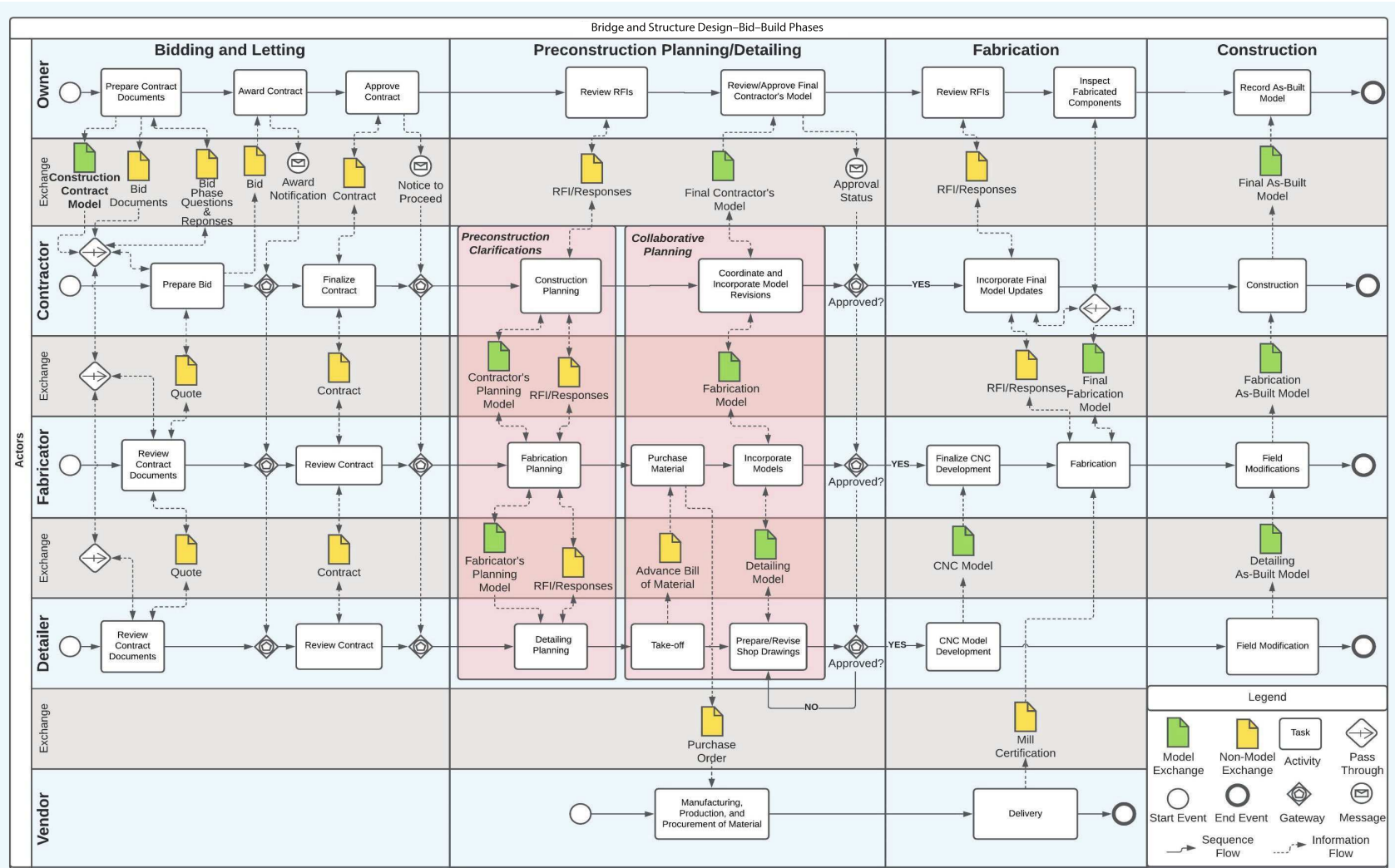


Figure 2.1.1-1—Bridge Construction Process Map

2.2—PROCESSES

This Section presents a bridge construction process map in Figure 2.1.1-1 that spans the bidding and letting through construction phases. The business use case occurs during the bidding and letting phase of the bridge lifecycle, as shown in Figure 2.1.1-1 as the “construction contract model.” The information provided during bidding and letting supports tasks in subsequent phases that result in the conclusion of construction. Appendix B provides additional context and a bridge lifecycle management overview map.

2.2.1—Processes Associated with the Construction Contract Model

Figure 2.1.1-1 maps the flow of exchanges in the bidding and letting through construction phases of a highway bridge or structure. The content and format shown in Figure 2.1.1-1 are based on work initiated by the AASHTO/National Steel Bridge Alliance (NSBA) Joint Task Group TG1 & TG15⁴, which was also reviewed by the TPF-5(372) members during its development.

This IDM only covers a single exchange of model-based information during the bidding and letting phase between the Owner and Contractor (the construction contract model). The construction contract model represents the model-based exchange of the graphical information and associated properties that form part of the contract documents, which are the complete set of information that the Owner delivers to the Contractor to facilitate construction.

All document- and message-based exchanges are excluded from this IDM. The construction contract model is associated with activities conducted by various actors that begin in the bidding and letting phase and end in the construction phase. Some of these activities involve the construction contract model being passed through other actors. The Contractor, Fabricator, and Detailer will use the information that the owner delivers as part of the construction contract model to perform their subsequent activities that result in the completion of construction. These subsequent activities do not involve a delivery of model-based information by the Owner and thus are excluded from this IDM. The subsequent model-based exchanges associated with the activities (which do not involve the Owner) are also excluded from this IDM.

A “model-based exchange” is not limited to graphical entities explicitly modeled in three dimensions; rather, it is a data set including graphical entities and the information attached to the modeled entities. For example, notes and tabular information required for construction (including fabrication) of a bridge are included in a model-based exchange. On the other hand, documents and contractual language for the overall project, such as forms, legal requirements, and bid submittal instructions, are included in a non-model-based exchange or message.

Figure 2.1.1-1 illustrates how the construction contract model is passed from the Owner to the Contractor and passed through to the Fabricator and Detailer in the bidding and letting Phase. Figure 2.1.1-1 also shows the activities associated with the information from the construction contract model that conclude in the construction phase. The Contractor’s subsequent activities are: finalize contract, construction planning, coordinate and incorporate model revisions, incorporate final model updates, and construction. The Owner provides document and message-based information and receives two model-based exchanges associated with these activities (i.e. final contractor’s model and final as-built model). The Owner only provides model-based information in the construction contract model and thus the construction contract model is the only exchange that is the subject of this IDM.

The business use case that is the subject of this IDM appears on Figure 2.1.1-1 as follows:

- **Provide Design Information to Execute Construction:** Model-based exchange of the construction contract model from Owner to Contractor that initiates the event that ends in the conclusion of construction.

- **Prepare Bid Package:** The Contractor’s activity labeled “Prepare Bid.”
- **Provide Design Information to Initiate the Fabrication Phase:** Pass-through of the construction contract model to initiate the “Review Contract Documents” activities for the Fabricator and the Detailer.

The construction contract model is delivered to the Contractor to initiate the Contractor’s activities. The contractor initiates other model-based exchanges delivering information to the Owner (i.e., final contractor’s model and final as-built model), but the Owner’s subsequent information deliverables to the Contractor are document- or message-based. The construction contract model is the delivery of model-based information from the Owner that the Contractor uses to complete the Contractor’s process at the end of construction.

The information contained within the construction contract model is not static. The information may change due to updates as a result of activities such as bid addenda, Requests for Information (RFI), and design revisions. Revisions to the contents of the construction contract model would be attached to the RFI/response document exchanges shown in Figure 2.1.1-1. The exchange requirement does not change; that is, individual properties (such as dimensions) may change, but the various elements, their properties, and the required amount of detail remains the same during the bidding and letting phase. For that reason, a single exchange, i.e., the construction contract model, is sufficient to fulfill the business use case supported by this IDM.

The process map was developed to reflect the design–bid–build contracting processes. While the sequence of exchanges or the actors involved in the exchanges may differ for other contracting models, the information exchange requirement may be applicable to design–build and construction manager/general contractor (CM/GC)⁵ delivery as well. That is, the information to be exchanged to facilitate the business use case is often the same, regardless of who the actors are and the order in which the actors exchange information, e.g. in design–build compared to design–bid–build procurement.

2.3—EXCHANGE

This IDM is focused on one specific information exchange, the construction contract model, which is shown in Figure 2.1.1-1. The construction contract model describes the model-based design information exchanged from the Owner to the Contractor during the bidding and letting phase for the purposes of supplying the design information necessary to execute construction. Table 2.3-1 is a standard set of information defining the exchange.

Table 2.3-1—Definition of Construction Contract Model

Phase	Bidding and letting
Creator	Owner
Users	Contractor, Fabricator
Purpose	For Contractors to execute construction, including subtasks such as preparing the bid package and initiating fabrication activities
Major Elements	Model-based graphical information and associated properties conveying the size, type, location, and other essential model-derived details sufficient for construction
Level of Detail	Final design conveying all graphical information and associated properties necessary for construction
Exporting Tools	Bridge model authoring software
Importing Tools	Software products that support quantity take-off, estimating, detailing, construction planning, scheduling, 3D model viewing, survey/layout

2.3.1—Phases

The following are definitions for the phases shown in Figure 2.1.1-1:

- **Bidding and Letting:** Phase in which the construction project is procured.
- **Preconstruction Planning/Detailing:** Phase between awarding the contract and commencing construction.
- **Fabrication:** Phase that manufactures the materials and components needed for construction.
- **Construction:** Phase in which the project is constructed.

As shown in Figure 2.1.1-1, the exchange associated with the construction contract model occurs during the bidding and letting phase. As described above, the Owner may provide updates to the design information during the pre-construction planning/detailing, fabrication, and construction phases through the RFI process.

2.3.2—Actors

The following are definitions for the actors shown in Figure 2.1.1-1:

- **Owner:** The entity or its authorized representative who has authority to define or accept changes to contract requirements. The Owner may have multiple representatives for various aspects or phases of the work, either as direct employees or through professional firms contracted for the work.
- **Contractor:** Manages the execution of construction in accordance with the scope, schedule, and performance specifications, using an understanding of the design and construction process and the relevant state and Federal laws. The Contractor may self-perform construction activities and/or hire sub-contractors to perform the work.
- **Fabricator:** Creates new products or specialized items for purchase.
- **Detailer:** Creates and documents the parts and components of new products or specialized items in detail using an understanding of the fabrication process.
- **Vendor:** Supplies products or items for purchase. The Vendor is the actor that supplies the materials.

2.3.3—Activities

This Article lists the activities related to the construction contract model as shown in Figure 2.1.1-1. The activities are organized by the actor. The following tables are based on work performed by the AASHTO/NSBA Steel Bridge Collaboration Joint Task Group TG1 & TG15 using the same process map shown in Figure 2.1.1-1.

2.3.3.1—Owner

The only activity for the Owner related to the construction contract model is “Prepare Contract Documents.” Table 2.3.3.1-1 defines this activity.

Table 2.3.3.1-1—Definition of the “Prepare Contract Documents” Activity

Type	Activity
Name	Prepare Contract Documents
Phase	Bidding and Letting
Description	The Owner prepares documents that define the scope of the project and determine the contractual expectations for contract advertisement
Models	Sent: “Construction Contract Model” to the Contractor. Contractor passes through to Fabricator and Detailer
Documents	Sent: “Bid Documents” to the Contractor. Sent/Received: Bidirectional “Construction Contract Questions and Responses” between Owner and Contractor. Contractor passes through from/to Fabricator and Detailer
Messages	None
Related	Owner: Award Contract, Approve Contract, Review RFIs, Review/Approve Final Contractor’s Model, Review RFIs, Inspect Fabricated Components, Record As-Built Model activities Contractor: Prepare Bid Fabricator: Review Construction Contract Model activity Detailer: Review Construction Contract Model activity

2.3.3.2—Contractor

The only activity for the Contractor directly related to the construction contract model is “Prepare Bid.” Table 2.3.3.2-1 defines this activity. Table 2.3.3.2-1 lists the Contractor’s other associated activities that make use of the construction contract model information.

Table 2.3.3.2-1—Definition of the “Prepare Bid” Activity

Type	Activity
Name	Prepare Bid
Phase	Bidding and Letting
Description	Collaborating with the Fabricator and any other subcontractors, the Contractor reviews the scope and price of fabrication and detailing quotes and incorporates the other stakeholders’ bids in the Contractor’s bid to the Owner
Models	Received: “Construction Contract Model” sent by Owner Sent: “Construction Contract Model” passed through to Fabricator and Detailer
Documents	Received: “Bid Documents” sent by Owner Sent: “Bid Documents” passed through to Fabricator and Detailer. Sent/Received: Bidirectional “Quote” between Contractor and Fabricator. Fabricator passes through from/to Detailer. Sent: “Bid” to Owner
Messages	None
Related	Owner: Prepare Contract Documents activity Contractor: Finalize Contract, Construction Planning, Coordinate and Incorporate Model Revisions, Incorporate Final Model Updates, and Construction activities Fabricator: Review Construction Contract Model activity Detailer: Review Construction Contract Model activity

2.3.3.3—Fabricator

The only activity for the Fabricator related to the construction contract model is “Review Contract Documents.” Table 2.3.3.3-1 defines this activity. Table 2.3.3.3-1 lists the Fabricator’s other associated activities that make use of the construction contract model information.

Table 2.3.3.3-1—Definition of the Fabricator's “Review Contract Documents” Activity

Type	Activity
Name	Review Contract Documents
Phase	Bidding and Letting
Description	The Fabricator reviews the relevant parts of the construction contract model and bid documents to prepare the quote. The Fabricator receives a quote from the Detailer and incorporates the cost into the fabrication quote sent to the Contractor. During this activity, there may be negotiations with the Detailer and/or Contractor resulting in bidirectional document exchanges for the quote.
Models	Received: “Construction Contract Model” from the Owner passed through by the Contractor Sent: “Construction Contract Model” passed through to the Detailer
Documents	Sent/Received: Bidirectional Bid Documents and Quote to/from the Contractor and Detailer
Messages	None
Related	Owner: Prepare Contract Documents activity Contractor: Prepare Bid activity Fabricator: Review Contract, Fabrication Planning, Purchase Material, Incorporate Models, Finalize CNC Development, Fabrication, and Field Modifications activities Detailer: Review Contract Documents activity

2.3.3.4—Detailer

The only activity for the Detailer related to the construction contract model is “Review Contract Documents.” Table 2.3.3.4-1 defines this activity. Table 2.3.3.4-1 lists the Detailer’s other associated activities that make use of the construction contract model information.