Information Delivery Manual (IDM) for Cast-in-Place Concrete

Reported by ACI Committee 131

ACI 131.1R-14

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First Printing
January 2015
ISBN: 978-0-87031-992-1

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Information Delivery Manual (IDM) for Cast-in-Place Concrete

Reported by ACI Committee 131

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This document provides a framework for enabling efficient interdisciplinary coordination and collaboration for exchanging information in both model and nonmodel forms. This report develops a process model that identifies the typical workflows during engineering design, planning, and site production of cast-in-place (CIP) reinforced concrete. It identifies what information and when it is to be shared between disciplines at different stages of CIP concrete projects. The process model relates the different disciplines that deliver the project, the different phases of the project, and the information exchanges that take place. This report will be used by building information modeling (BIM) users and software developers as a framework for developing shareable model views for visualization and coordination of production and placement of reinforced concrete.

Keywords: building information modeling; exchange descriptions; information delivery manual; task descriptions; work process flow chart.

CONTENTS

ACI 131.1R-14 was adopted and published January 2015.

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

The National BIM Standard – United States™ (NBIMS-US™ 2013) defines standard and efficient terminology and semantics to be exchanged in building information models to support various business use cases throughout architecture, engineering, construction, and operations projects. The project committee responsible for developing the NBIMS-US™ is a committee of the buildingSMART (2013) alliance, a council of the National Institute of Building Sciences.

The NBIMS-US™ establishes the standard process to develop the NIBS standard. The process includes four phases.

1. *Program*—Defines information exchange requirements that may be standardized by developing process models and defining specifications and business rules for each exchange. An information exchange is the transfer of data in context between various entities along the cast-in-place (CIP) concrete supply chain (that is, from the architect to the structural engineer). In this phase, a process model that identifies the required tasks and where the information exchanges take place in the project lifecycle, as well as the entities such as engineers, reinforcing bar detailers who develop or use information, and software applications, which are the senders and recipients of these exchanges, is developed. The information exchanges are defined by exchange models that specify the functional requirements (content and format) of data exchanges to be implemented. When the process models and exchange models are combined, they form an information delivery manual (IDM). This IDM serves as the overall functional requirements specification for one or more exchanges.

2. *Design*—Develops exchange requirement models and generic model view definition (MVD).

3. *Construct*—Develops software implementation specifications for MVD and facilitates product testing and certification of information exchanges.

4. *Deploy*—Provides generic and product-specific building information modeling (BIM) guide, validates data exchange, and extends the complexity of information that can be included in the BIM data.

1.2—Scope

This report is intended to enable accurate and efficient creation, sharing, modification, and reuse of cast-in-place (CIP) concrete model information among various project entities throughout a project lifecycle. Specifically, a process model that identifies the typical workflows during engineering design, planning, and site production of concrete is developed. It identifies when information is shared between disciplines at different stages of projects. The tasks and information exchanges that make up the process model are defined.

CHAPTER 2—DEFINITIONS

building information modeling—processes and technology that use a digital representation of the physical and functional characteristics of a project.

exchange models—description of the information exchanged and the typical producer and receiver of that information.

information delivery manual—report identifying user requirements for one or more information exchanges.

model view definition—software specification of exchange requirements for one or more data exchanges.

CHAPTER 3—INFORMATION DELIVERY MANUAL OVERVIEW

3.1—Background

An information delivery manual (IDM) defines exchange requirements in the context of reference industry processes. IDMs are defined by end users and practicing professionals to support the process in which they are expert. The resulting IDM serves to define the exchange requirements for one or more building information modeling (BIM) transactions.

The IDM is focused on end-user exchange requirements supporting a given set of workflows. The exchange requirements are captured by developing a process model that defines the context of the workflows of interest. The process model identifies the sets of use case exchanges being addressed, the tasks involved in each phase of the project, and the exchange requirements that will enhance the workflow. The various components of the IDM capture the user needs and specification of the exchanges in a form that can serve as the functional requirements for the technical exchange specification, called a model view definition (MVD). Thus, the IDM is developed by users to specify what they need for a target workflow, to be translated later by the MVD into computer-implementable code.

This report defines the functional data exchange requirements and workflow scenarios for exchanges among all the entities involved in the cast-in-place (CIP) concrete supply chain during each phase of a project. There are a wide variety of CIP concrete elements used in construction projects, including different types of footings, beams, columns, walls, slabs, ramps, corbels, piles, and piers. These are mostly used as part of the structural system of facilities. The different elements are often designed and produced by separate business entities that include formwork design and

Table 3.1a—Omniclass designation for project disciplines

Project discipline	Omniclass designation	Project discipline	Omniclass designation
Architecture	33-21-11-00	Structural engineer	33-21 31 14
Civil engineer	33-21 31 11	Mechanical engineer	33-21 31 17
Reinforcing detailer	33-41-11-14	Reinforcing fabricator	33-41 11 14
Batch plant	33-41 21 24	Testing agency	33-25 54 00
Concrete contractor	33-41 11 14	Reinforcing contractor	33-41 11 14 17
Formwork contractor	33-41 11 14	Finish contractor	33-41 11 14
General contractor	33-41 11 11	Site contractor	33-41 11 14
Reinforcement distributor	33-25 41 11	Owner/client	33-55 21 00

Notes: Omniclass is part of the ISO 12006-2 standard. ISO 12006-2 defines methods of organizing the information associated with construction and affiliated industries, and also promotes a standard object-modeling definition for concepts addressed.

erection, reinforcement detailing, fabrication and placement, design of concrete mixture proportions, placing, testing and curing, and concrete finishing. Moreover, CIP concrete, as a fundamental building system, interacts with many other aspects of a building in the following ways:

(a) Concrete walls might be connected to steel or precast concrete beams and precast concrete or composite slabs, and sometimes to concrete columns.

(b) Concrete may encase or otherwise be connected to steel, creating composite members, including composite beams, columns, shear walls, slabs, and braces.

(c) Mechanical, electrical, and plumbing (MEP) products cross CIP concrete elements.

(d) The site excavation plan and execution schedule are important for design and execution of concrete foundations.

There are 16 different disciplines identified in the process model developed in this report (Table 3.1a).

Exchanges are defined for six different phases of a project (Table 3.1b). To accommodate the diversity and variety of disciplines involved, efficient communication and collaboration of the different disciplines during each project phase is required. Designers and producers of CIP concrete elements may choose to use a variety of software tools to generate information. Hence, enabling efficient interdisciplinary coordination and collaboration requires exchange of information between different software platforms in model and nonmodel forms. This report identifies and documents the information items that each discipline involved in design, planning, production, and site construction of CIP concrete needs to share with other disciplines at different stages of the projects.

Workflows within the CIP concrete supply chain are not standardized, but are tuned dynamically to reflect what is most appropriate for a given project and stage. Some processes might vary based on the selected delivery method and specific contract terms designated for a project. The definitions of workflows in this report are tied into an overall process and a typical illustrative schedule, not as a prescriptive process. The process model is laid out to provide a structure for addressing different use cases of information exchange; they are not intended to be used as a prescriptive process.

Table 3.1b—Omniclass designation for project phases

Project phase	Omniclass designation
Design development	31-20-20-00
Construction documentation	31-25-00-00
Concrete resource and placement planning	31-40-30-31
Concrete execution	31-40 40 24
Erection phase	31-40-40-14-11
Turnover	31-40-40-91-31

3.2 —Information delivery manual hierarchy

Figure 3.2 illustrates the hierarchical structure used to develop an information delivery manual (IDM), which includes the following.

a) Process models (Appendixes A through D): this is defined for the general processes identified for cast-in-place (CIP) concrete construction projects. The process models identify the tasks carried out and the typical phase of design in which they are carried out. They also define the exchanges required to support the flow of information needed to accomplish those tasks; these are called exchange models. The full process models (Appendix A) have been filtered to show only those tasks and information exchanges related to a certain portion of the CIP supply chain. Appendixes B through D show submodels for supply of concrete material such as shoring and formwork, and design, detailing, supply, and installation of reinforcement. The tasks, exchange models, and nonmodel exchanges identified in the process model throughout the lifecycle of a CIP concrete project are described in short paragraphs (Appendix E), allowing cross-referencing back to the process model.

b) The detailed exchange models are fully reported in the consolidated exchange model tables in Appendix E. This provides a structure and definition of the exchange functionality for future implementation.

c) An exchange requirement table is part of the process for developing a model view definition (MVD). The functional requirements for the MVD are not included in this report.

CHAPTER 4—PROCESS MODEL

4.1—Protocol for process model

One or more process models identify the tasks, actors, and information flow throughout the life cycle of a project that are to be supported by building information modeling

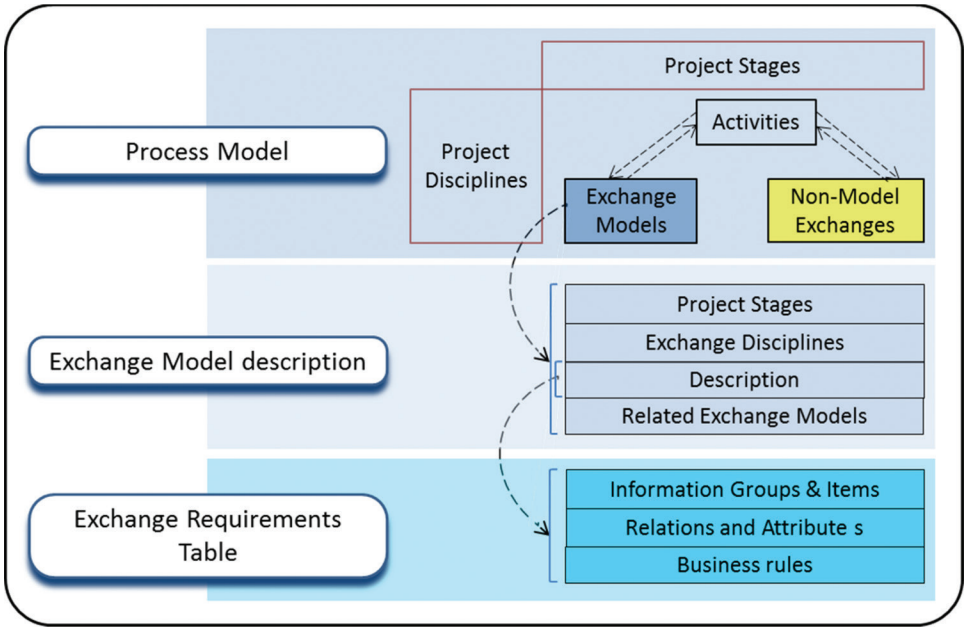


Fig. 3.2—IDM hierarchical structure.

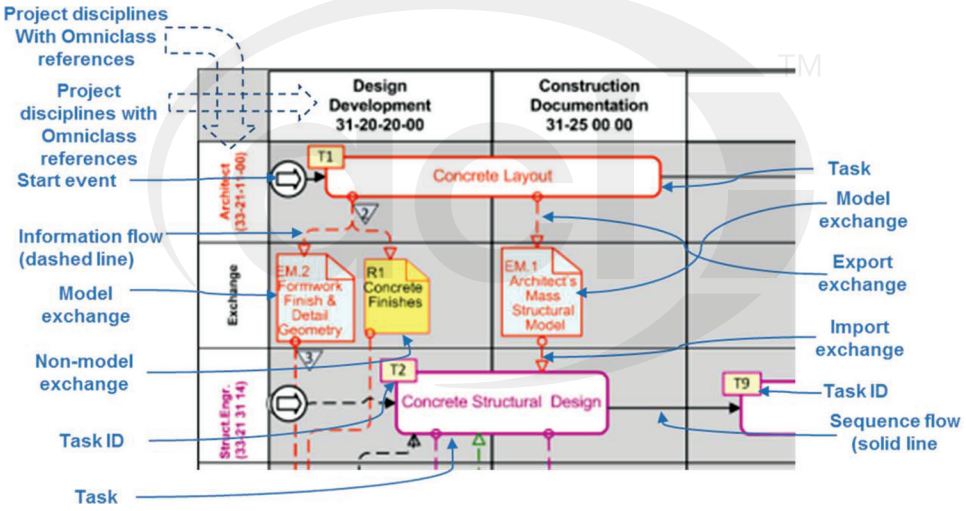


Fig. 4.1—BPMN notation guide.

(BIM) tools. These models identify the relationship of tasks and information that are either used as an input to perform tasks or are outputs as a result of performing tasks. They help determine the information value chain throughout projects, identify the inefficiencies of current practice, and assist in eliminating the non-value-adding or lesser-value-adding information-based activities.

Business process modeling notation (BPMN), developed by Object Management Group (2013), is a standard for expressing process models that are flow-oriented representations of business operations. Models represented by BPMN have been used to facilitate information exchange and communication between project participants and to aid with decision making based on various analysis techniques. Detailed BPMN models are, however, increasingly used to identify the information packages exchanged in business processes and to define required software features for vendors. The process models for cast-in-place (CIP) concrete are presented in Appendixes A through D. The main components of process models developed using BPMN are illustrated in Fig. 4.1 and include flow objects and connecting objects. Flow objects represent tasks or decision-making gateways. Connecting objects capture either the information flow between tasks that are carried out as a result of tasks or the logical sequence of tasks. The information flows are of two types: model data and nonmodel data.

BPMN uses a matrix of rows and columns to categorize tasks with different functional objectives or capabilities. Columns represent the various stages of the project. Some rows contain tasks performed during project delivery, and other rows contain the exchange requirements of a data source that may be carried either by a BIM tool in the form of a model, referred to as exchange models, or other non-BIM forms of information exchange; for example, informal

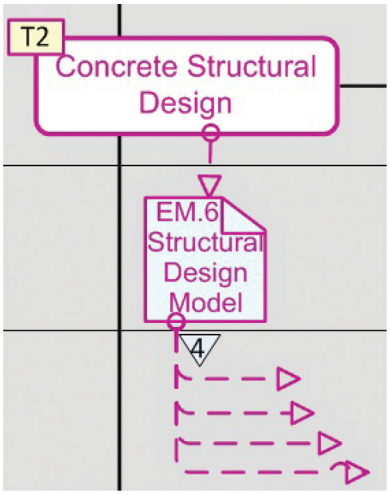


Fig. 4.2.1.1—Notation consolidation.

comments on the architectural design by the structural engineer. Exchange models are used to provide the content of information exchanges between users, software applications, or both. Further, to provide appropriate levels of development, tasks may be broken down into subprocesses, such as the information exchange between the architect and the structural engineer, that may be executed multiple times concurrently.

BPMN models are useful for identifying the exchange models in CIP concrete construction projects and provide a base to later identify the content of each information exchange package in the information delivery manual (IDM). In the BPMN model, Omniclass designations for project phases and project disciplines that participate in developing and delivering projects are used (Tables 3.1a and 3.1b).

Major process phases are identified in the context of their relation to CIP concrete construction. Omniclass classification is used to identify their relation to the overall construction process (Omniclass 2013). In addition to the standard BPMN notation, the IDM uses notation for information exchanges between exchange models. Information exchanges in nonmodel forms, such as text and tables, are also identified and described.

4.2—Rules for formatting process model

Process models can be large and complex. For this reason, they must be created with readable and logically correct protocol using business process modeling notation (BPMN). There are two primary considerations in creating process models: 1) formatting to facilitate readability; and 2) ensuring a logical information flow. These are described more fully as follows.

4.2.1 *Methods for formatting to facilitate readability*

4.2.1.1 *Aggregating information flows*—Multiple information flows leaving a model or nonmodel exchange are aggregated into a single pipe flow with branches, with a triangle identifying the number of flows in the pipe (Fig. 4.2.1.1).

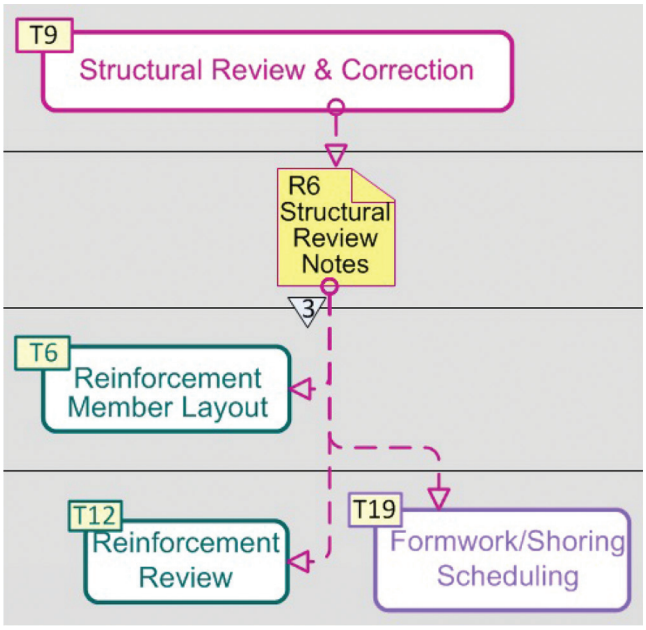


Fig. 4.2.1.2—BPMN notation guide: connectivity and color coding of information flows.

Table 4.2.1.3—Color codes for task boxes

Architect	Structural Engineering
Civil Engineering	Mechanical Engineering
Reinforcing Detailer	Reinforcing Fabricator
Batch Plant	Testing Agency
Concrete Contractor	Reinforcing Contractor
Formwork Contractor	Finish Contractor
General Contractor	Site Contractor

4.2.1.2 *Connection of all links*—For traceability and reading, all information flows are fully connected (Fig. 4.2.1.2). The lines illustrating the information flow are color coded to the task from which the information originates.

4.2.1.3 *Coding of discipline information flows*—To facilitate visual tracking of information flows, each discipline should contain the tasks performed by the discipline; all the information generated by those tasks; and information flows from those tasks to generated models and, ultimately, to receiving tasks. Each discipline is distinguished by a specific color (Table 4.2.1.3 and Fig. 4.2.1.3).

The only exception for this rule is reinforcement-related disciplines. To decrease the variety of colors used and make the tasks easier to trace, information models and connection links of four disciplines of reinforcing detailer, reinforcing fabricator, reinforcing contractor, and reinforcement distributor are designated the same color.

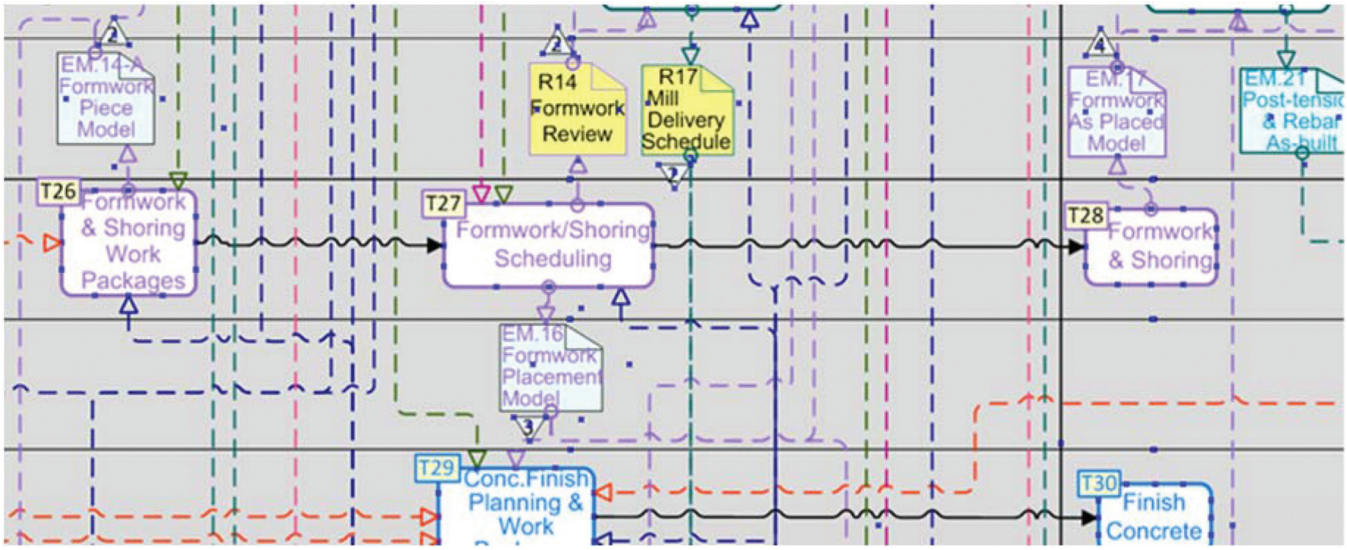


Fig. 4.2.1.3—BPMN notation guide: information flows from a source are coded to be same color as source.

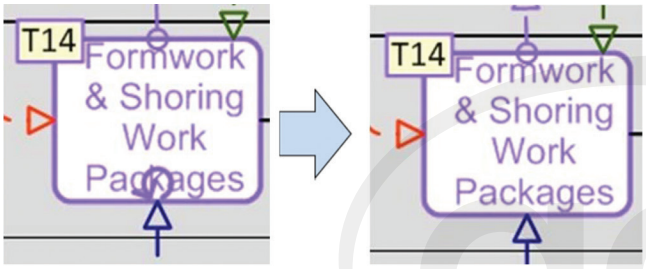


Fig. 4.2.1.4—BPMN uses a loop symbol to indicate iterated tasks. It is assumed that all tasks can be iterated; the loop was removed to enhance readability.

4.2.1.4 *Hidden loop markers of tasks*—Usually several rounds of design, review, and modification go into producing each exchange model and nonmodel information produced by each activity. In BPMN models, this iteration of tasks is normally illustrated by loop markers (refer to left side of Fig. 4.2.1.4). Due to the complexity of the CIP concrete process model, the fact that planning of one placement cycle is proceeding at the same time as the execution of others, and to improve readability, these loop markers are removed (refer to right side of Fig. 4.2.1.4). It should be noted that the nature of most tasks in the CIP concrete design and production lead to several rounds of review and modification.

4.2.1.5 *Ensuring logical information flow*—An activity or exchange model in a later phase activity cannot inform an activity in an earlier phase. As can be seen in Fig. 4.2.1.5a, EM.13 is generated in the Concrete Resource Planning phase and T16 occurred in the Construction Documentation phase. Therefore, when T16 occurs, EM.13 has not yet been generated and cannot be used as an input for T16. In these cases, some tasks are iterated across multiple project stages or they can happen in different stages of a project, depending on selected project delivery method and contract terms. In such cases, the tasks are extended to both reflect this iteration and cover different situations.

Tasks within a row receive all the information in the tasks to the left in the row because they are received by the same discipline. They need not be explicitly linked (Fig. 4.2.1.5b).

4.2.1.6 *Single application*—Exchange models are the product of a single application. As an exchange between applications, only one application can generate the data for a model or nonmodel view (Fig. 4.2.1.6). In this figure, a software application is used to prepare a construction resource plan, EM.12. Information from other applications may be used in EM.12, but all information flowing to this exchange must pass through the resources planning application.

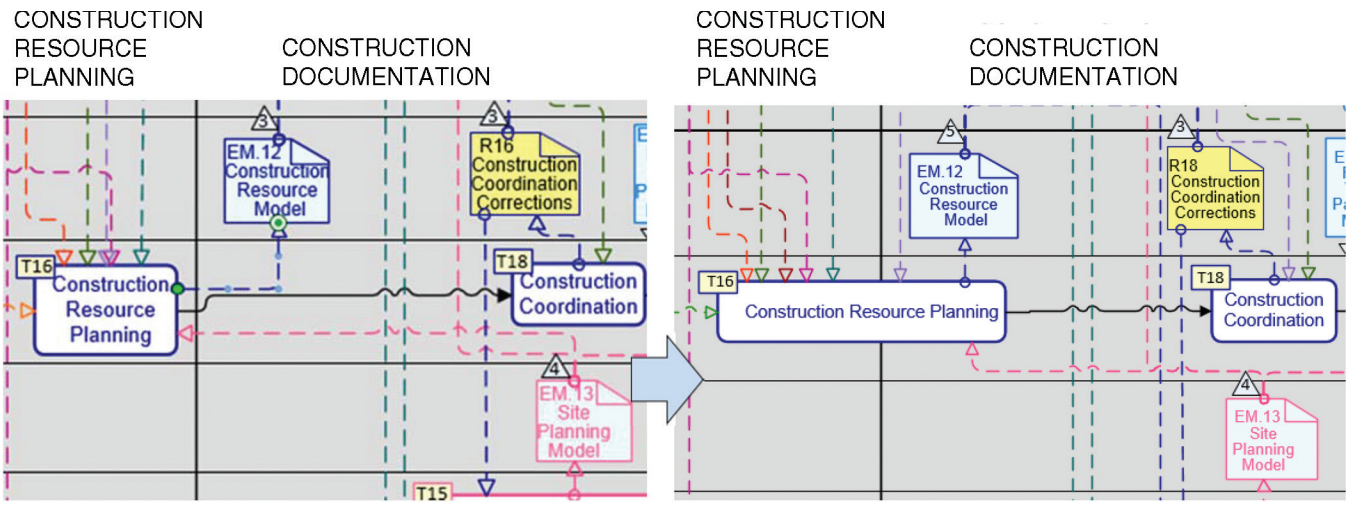


Fig. 4.2.1.5a—Adjustment of column alignment for flow direction consistency.

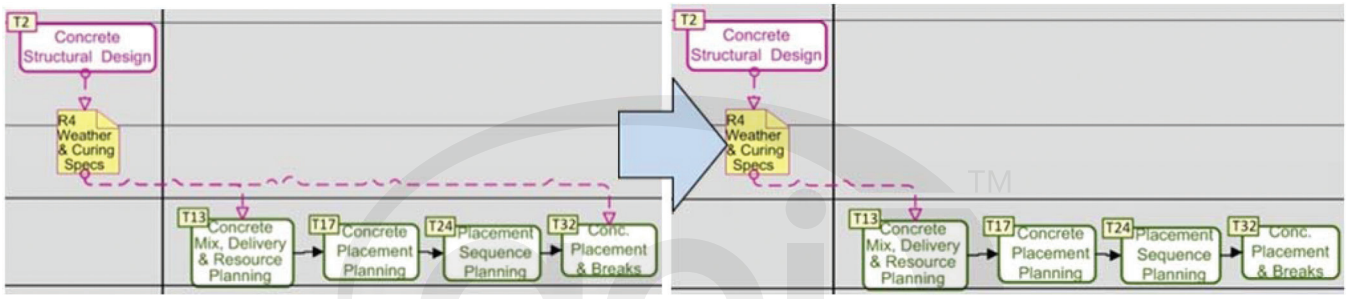


Fig. 4.2.1.5b—Implicit information flows within a task row.

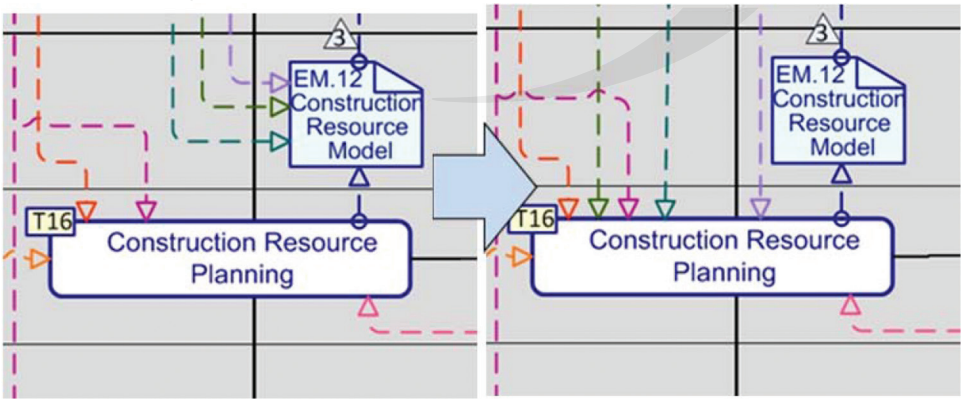


Fig. 4.2.1.6—IDM for reinforced concrete supports application to application exchange.

Table 5a—Task description template

Project phase	Omniclass project stage
Discipline	Name and Omniclass discipline number of the activity performer
Information obtained from	Name and Omniclass discipline number of the disciplines who send their generated model information, nonmodel information, or both, as an input to enable execution of this activity.
Task description	Written description of: 1. The purpose of the activity 2. Task execution process

Table 5b—Exchange model description template

Project phase	Omniclass project stage
Exchange disciplines	Parties to this exchange From: To: By Omniclass discipline number and name. (can be more than two disciplines, but using the same basic data)
Description	Written description of: 1. The purpose of the exchange 2. Major elements of the exchange 3. The level of development of the exchange 4. Any special attributes
Software functionality	Export and import attributes
Related exchange models	Other exchanges this one interacts with (proceeding and succeeding exchanges)

CHAPTER 5—TASK, EXCHANGE MODEL, AND NONMODEL INFORMATION DESCRIPTIONS

Written documentation is required to describe the intent of the tasks and exchanges identified in the process models. These descriptions are linked by identifiers to the process model. All exchange models in the process models are described in the context of their project stage and exchange disciplines. Exchange model descriptions are generic and outline the typical content of the information exchanges between specified tasks. They identify which objects, processes, properties, relations, and classifications are both relevant to the receiving (importing) application and available in the sending (exporting) application (Table 5a through 5c).

The term "information items" is used to refer to items that need to transfer information. These may represent physical objects (such as gravity retaining wall or precast double tee beam) or nonphysical objects (such as wind loads or activity schedules). The goal in developing the exchange descriptions is to specify these information items and their attributes in sufficient detail that the coverage of exchanges will be understood. They are initially identified contextually in the process models and are described in more detail in the model and nonmodel exchange descriptions. Nonmodel exchange descriptions are also provided.

Table 5c—Nonmodel exchange description template

Project phase	Omniclass project stage
Discipline from	Omniclass discipline number and name of the discipline generating this nonmodel information.
Discipline(s) to	Omniclass number and name of disciplines who receive the generated nonmodel information.
Information transmitted	Written description of: 1. The purpose of the exchange 2. The required contents of the exchange 3. The optional contents of the exchange
Typical formats	Formats in which the nonmodel information is exchanged.

The task and information exchange descriptions, coupled with the process model(s), are the essence of the information delivery manual (IDM). The IDM will guide the development of the model view definition (MVD)

CHAPTER 6—REFERENCES

Committee documents are listed first by document number and year of publication followed by authored documents listed alphabetically.

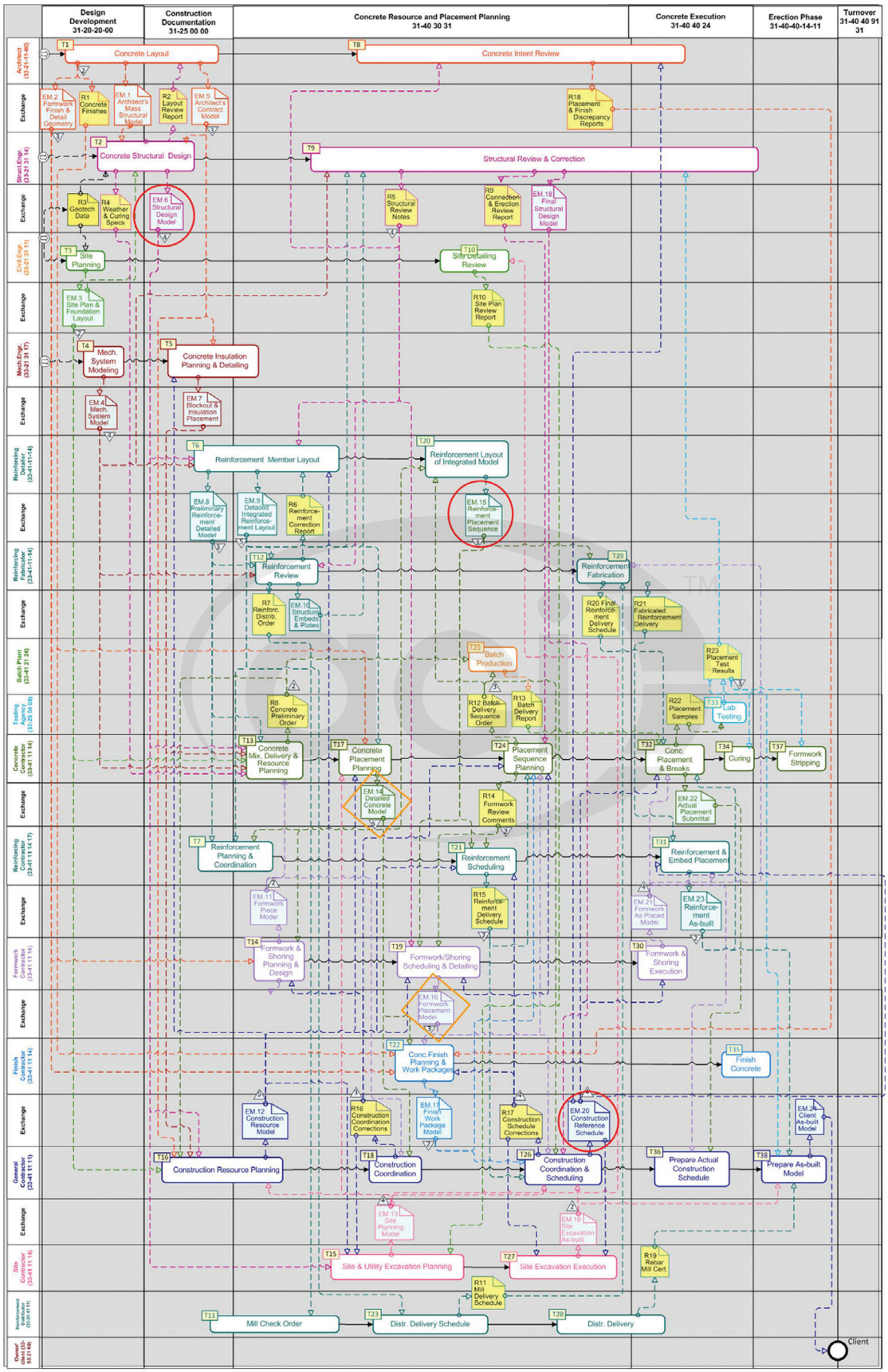
International Organization for Standardization, ISO 12006-2:2001 Building Construction—Organization of Information about Construction Works—Part 2: Framework for Classification of Information buildingSMART International website, http://www.buildingsmart-tech.org (accessed, July 14, 2013).

National BIM Standard – United States™ (NBIMS-US™) http://www.nationalbimstandard.org (accessed, July 14, 2013).

Object Management Group, Business Process Model and Notation, http://www.bpmn.org (accessed July 14, 2013).

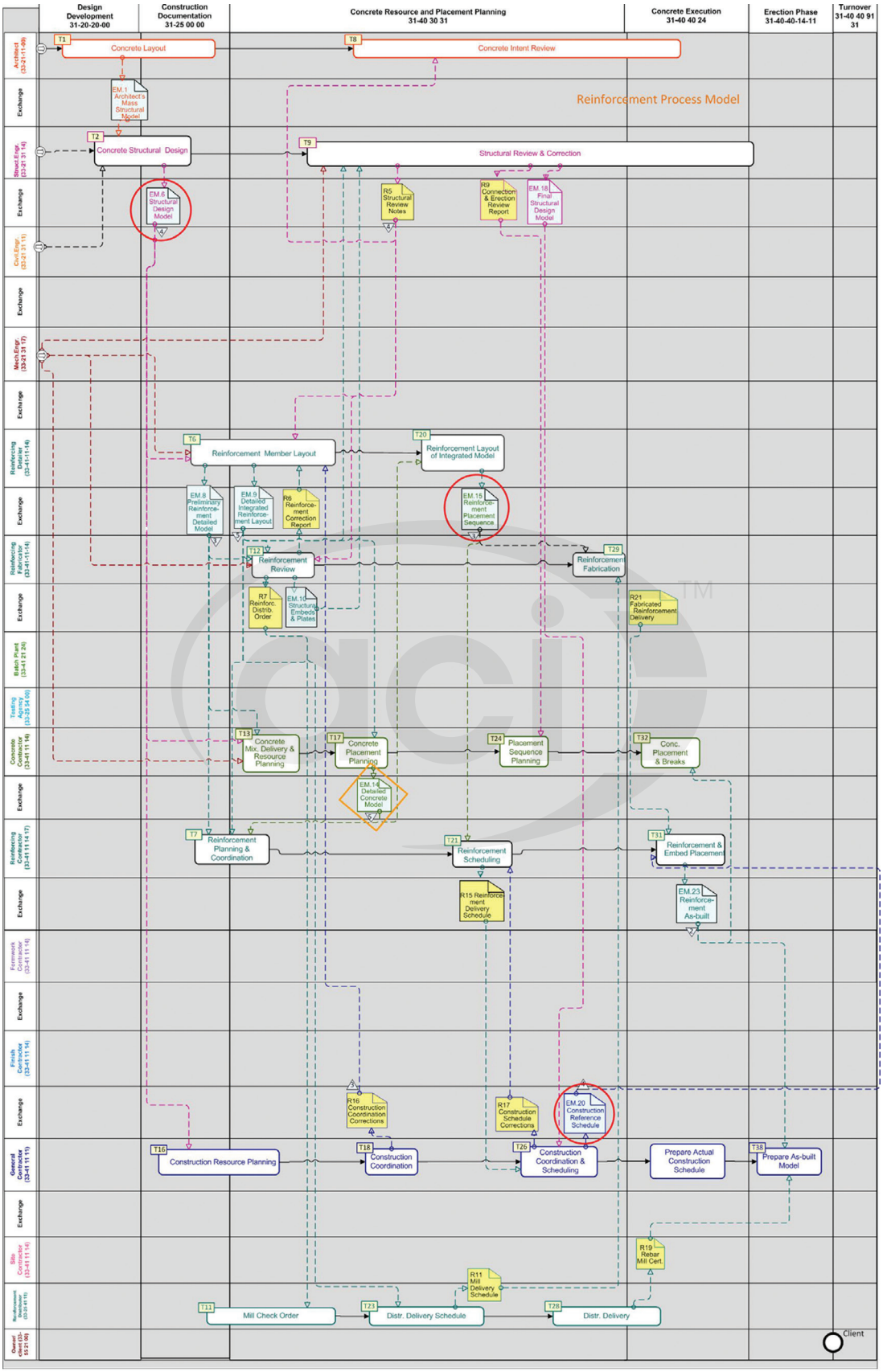
OmniClass Construction Classification System, Table 31 Phases and Table 33 Disciplines, http://www.omniclass.org (accessed, July 14, 2013).

APPENDIX A—COMPLETE CAST-IN-PLACE CONCRETE PROCESS MODEL



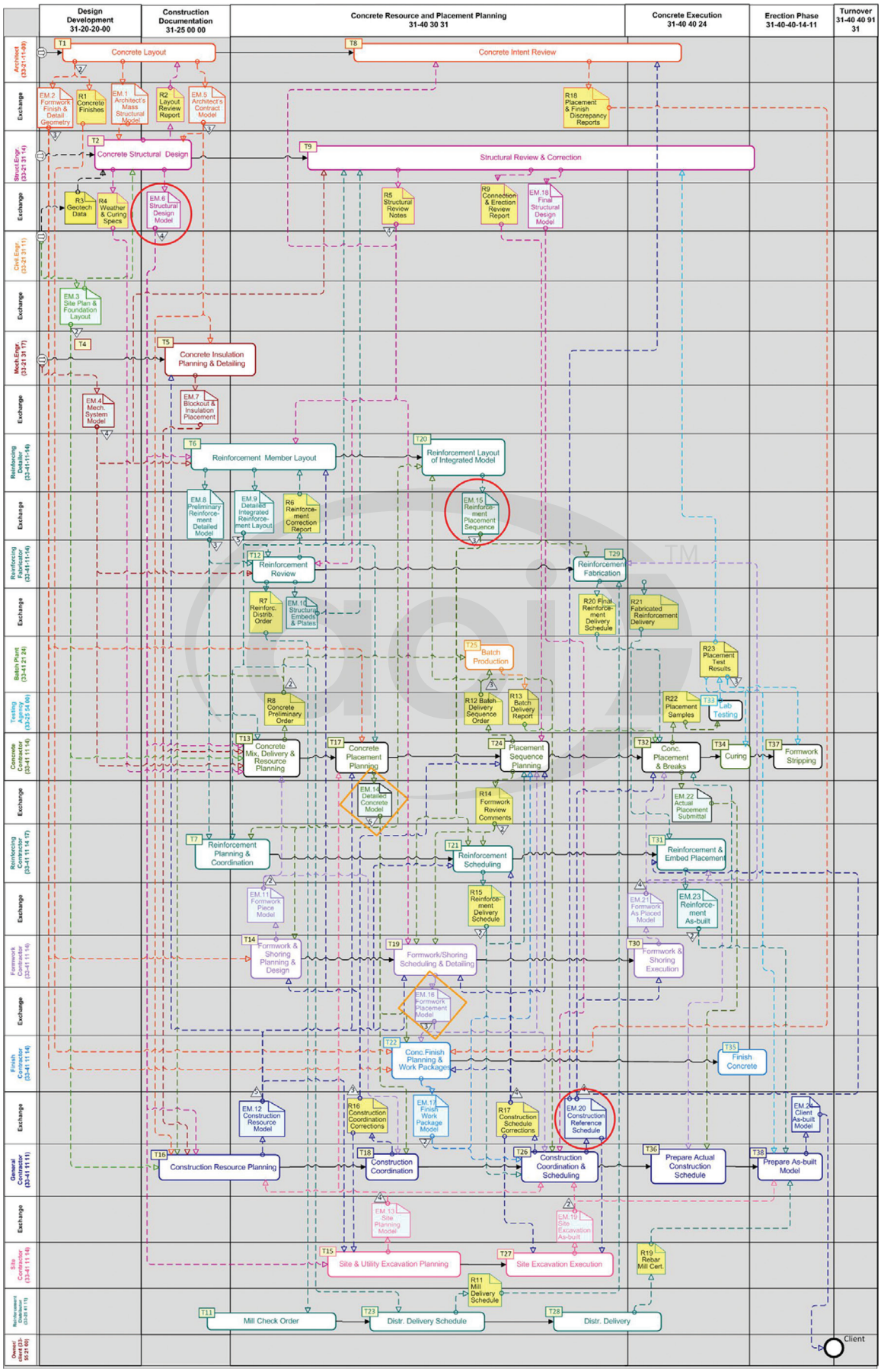
Notes: Red circle indicates primary exchange for developing MVD; yellow diamond indicates secondary exchange for developing MVD.

APPENDIX B—CONCRETE REINFORCEMENT SUBPROCESS MODEL

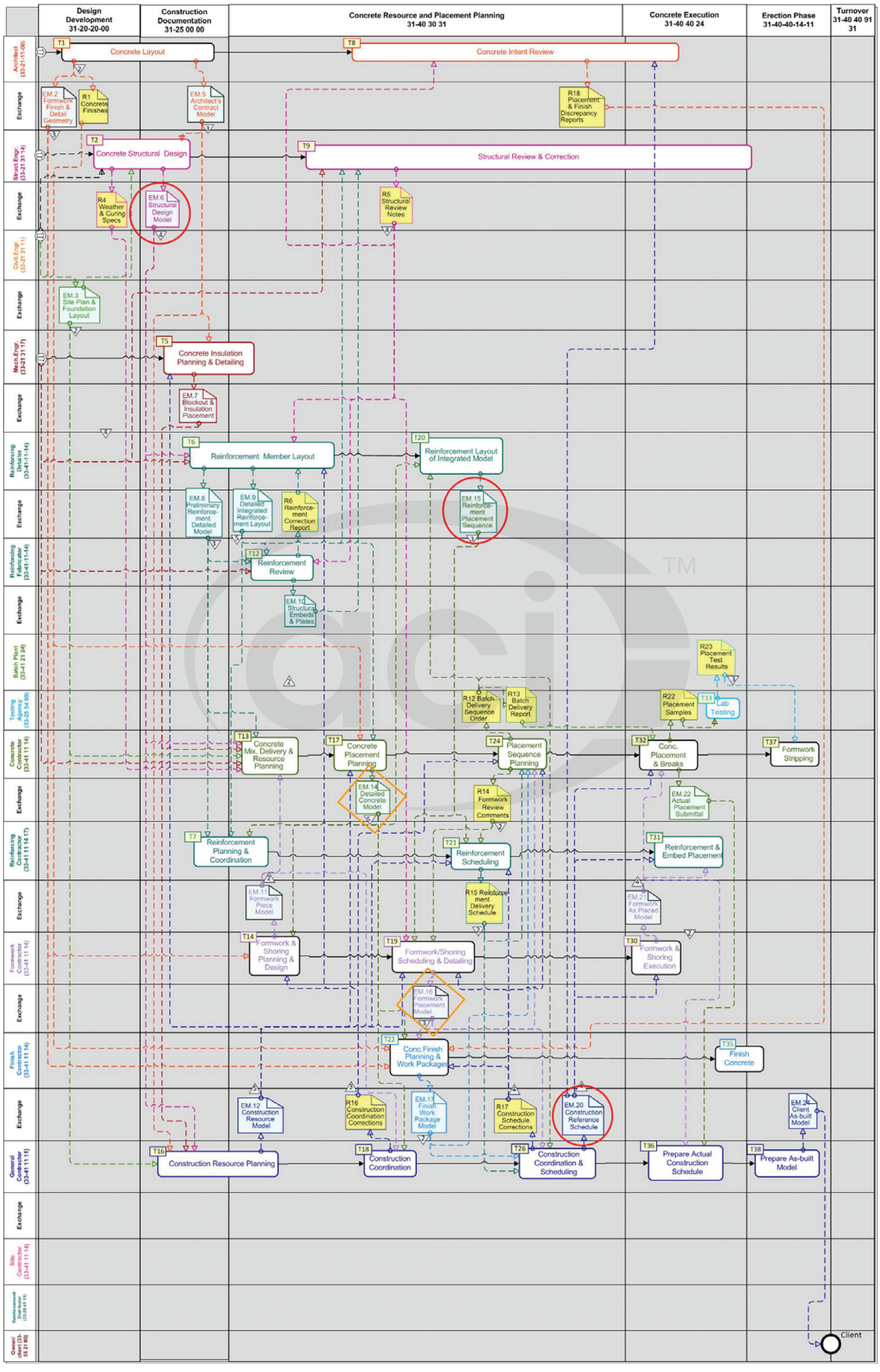


Note: Appendix B is a subprocess model extracted out from the full model (Appendix A) to facilitate process tracking of information exchanges related to reinforcement. Appendix C breaks out concrete placement centered exchanges; Appendix E breaks out formwork and shoring centric exchanges.

APPENDIX C—CONCRETE PLACEMENT SUBPROCESS MODEL



APPENDIX D—CONCRETE FORMWORK AND SHORING SUBPROCESS MODEL



APPENDIX E—DESCRIPTIONS OF CAST-IN-PLACE REINFORCED CONCRETE TASKS AND MODEL AND NONMODEL EXCHANGE DESCRIPTIONS

(I) TASK DESCRIPTIONS

The following tasks and subprocesses define the tasks (T), the exchange models, and the nonmodel exchanges (R) that relate to the process. Disciplines and project stages are noted using Omniclass (refer to Tables 3.1a and 3.1b).

T1—Concrete layout

Design phase:
Design development 31-20-20-00
Construction documentation 31-25 00 00
Discipline:
Architect 33-21-11-00
Information obtained from:
This task elaborates a concept model, complete to level of architect's design development; information is obtained from all facility type consultants, mechanical and equipment engineers, landscape and site consultants, and preliminary review of structural engineers.
Task description:
The architects or designers produce the reinforced concrete aspects of a construction project, in terms of spatial layout, shapes, and approximate dimensions. This design includes foundations, site development and retaining walls, and concrete roads and paths. Surface finishes and textures for architectural finishes are defined.

T2—Concrete structural design

Design phase:
Design development 31-20-20-00
Construction documentation 31-25 00 00
Discipline:
Structural engineer 33-21 31 14
Information obtained from:
Receives architect's model and general facility layout and site plan. Also receives site development, including paths and roadways, retaining walls and other site improvements, and geotechnical model or data from site engineer.
Task description:
Determines applicable code loading conditions and other structural requirements. Defines and analyzes structural model in sufficient detail to ensure requirements will be met. Model typically includes all member sizes and reinforcing and tendons. Also includes foundations and retaining walls.

T3—Site planning

Design phase:
Design development 31-20-20-00
Discipline:
Civil engineer 33-21 31 11
Information obtained from:
Architect or site planner, geotechnical consultant, surveyor, or all of these.
Task description:
Develops or imports already defined model of site plan with general placement of building, all site improvements including pathways and roads, steps, retaining walls or other earth retainers, and planting and landscape areas. Places subterranean infrastructure such as sewer lines, existing or planned cisterns, and water catchment or drainage improvements, if existing or planned. Information sufficient for contractual bidding.

T4—Mechanical system modeling

Design phase:
Design development 31-20-20-00
Discipline:
Mechanical engineer 33-21 31 17
Information obtained from:
Prepares mechanical equipment information needed for structural engineering contract documents.
Task description:
Integrates all mechanical equipment and electrical and plumbing systems into a mechanical system model appropriate for bidding. Model for concrete work includes reference models to major mechanical equipment with approximate loads, major supply lines, and other services that may affect concrete detailing, including blockouts. Also includes all mechanical equipment connection plates and hardware.

T5—Concrete insulation planning and detailing

Design phase:
Construction documentation 31-25 00 00
Concrete resource and placement planning 31-40 30 31
Discipline:
Mechanical engineer 33-21 31 17
Information obtained from:
General contractor identifies insulation and thermal barriers to be associated with foundation or other concrete placement tasks (comes from contractor).
Task description:
Mechanical engineer determines placement of insulation and thermal barriers to be associated with foundation or other concrete placement tasks (comes from contractor).

T6—Reinforcement member layout

Design phase:
Construction documentation 31-25 00 00
Concrete resource and placement planning 31-40 30 31
Discipline:
Reinforcing detailer 33-41-11-14
Information obtained from:
Receives reinforcing requirements from structural engineer, construction coordination model from general contractor, embeds, and plates.
Task description:
Generates a discrete piece model with reinforcing layout, including plates and embeds. Includes design and placement of tendons.

T7—Reinforcement planning and coordination

Design phase:
Construction documentation 31-25 00 00
Concrete resource and placement planning 31-40 30 31

Discipline:
Reinforcing contractor 33-41-11-14 17
Information obtained from:
Reinforcing review by contractor, based on preliminary layout; coordination and feedback from other trades.
Task description:
Reviews special needs and expected schedule requirements.

T8—Concrete intent review

Design phase:
Concrete resource and placement planning 31-40 30 31
Concrete execution 31-40 40 24
Discipline:
Architect 33-21-11-00
Information obtained from:
Reviews finish samples and finish field work, equipment, and other material placements for design intent.
Task description:
Reviews concrete placement, relation of equipment, and hardware placements; reviews finishes; and approves (or not).

T9—Structural review

Design phase:
Concrete resource and placement planning 31-40 30 31
Concrete execution 31-40 40 24
Discipline:
Structural engineer 33-21 31 14
Information obtained from:
Varied sources, including mechanical engineer, reinforcement detailer and fabricator, and concrete testing agency.
Task description:
This is an iterated activity. Structural engineer reviews all shop drawings and submittals and changes during construction planning to determine if structural intent has been violated. Proposes corrections as needed.

T10—Site detailing review

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline:
Civil engineer 33-21 31 11
Information obtained from:
Site contractor and general contractor.
Task description:
Reviews relevant site conditions and maintains and coordinates site issues associated with concrete placement and footings, retaining structures, and shoring.

T11—Mill check order

Design phase:
Construction documentation 31-25 00 00
Concrete resource and placement planning 31-40 30 31
Discipline:
Reinforcement distributor (33-25 41 11)
Information obtained from:
Reinforcing fabricator provides model of structural reinforcing.
Task description:
Concrete contractor identifies all nonstock reinforcing material required for project and generates mill order for steel or composite reinforcement. Makes sure order lead times are not an issue. May include special embeds.

T12—Reinforcing bar review

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline:
Reinforcing fabricator 33-41 11 14
Information obtained from:
Initial reinforcing bar review by fabricator, based on design requirements from structural engineer.
Task description:
Based on lengths, material specifications, and bending requirements, reinforcing bar is planned and initial production schedule set.

T13—Concrete mixture, delivery, and resource planning

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline:
Concrete contractor 33-41 11 14
Information obtained from:
Receives model data from site planning, structural engineer, mechanical engineer, formwork contractor, and reinforcement detailer including information of embeds and plates, connections, and structural building model.
Task description:
Determine resource needs and schedule for execution of concrete work packages. Includes delivery and lifting needs and rough schedule. Prepares preliminary mixture proportions selection and other concrete products (vapor barriers, water stop, and curing materials). Develops overall concrete and reinforcement execution plan.

T14—Formwork and shoring, planning, and design

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline:
Formwork contractor 33-41 11 11
Information obtained from:
Receives detailed concrete model and approximate schedule and construction coordination model.
Task description:
Develops general formwork and shoring plan; addresses sources of formwork and scaffolding and special shoring systems. Generates shoring work packages.

T15—Site and utility excavation planning

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline:
Site contractor 33-41 11 14
Information obtained from:
Civil (site planning) engineer, structural engineer, reinforcement contractor, and construction coordination model.

Task description:

Refines site model addressing both construction use as yard for materials and supplies, and also for site improvements and infrastructure. Of particular special relevance are access and material delivery planning, safety reviews, scheduling the major site construction, and providing options for shoring and formwork.

T16—Construction resource planning

Design phase:

Construction documentation 31-25 00 00

Concrete resource and placement planning 31-40 30 31

Discipline:

General contractor 33-41 11 11

Information obtained from:

Information from all subcontractors and fabricators, regarding their general three-dimensional layouts in the facility. Receives logistical material flow requirements.

Task description:

Identifies material flows for the project, including truck deliveries; concrete deliveries; and crane, lifts, and other people and material vertical movement systems. Resolves conflicting requirements.

T17—Concrete placement planning

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Concrete contractor 33-41 11 14

Information obtained from:

Elaborates concrete model to incorporate reinforcing bar placement plans, detailed geometry, formwork placement, mechanical system model for embeds and blockouts, and structural review and construction coordination model.

Task description:

Develops initial pour sequence, based on all preparatory tasks dealing with reinforcement and formwork.

T18—Construction coordination

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

General contractor 33-41 11 11

Information obtained from:

Working fabrication-level models from all fabricators and subcontractors.

Task description:

Coordination review by general contractor, considers all in-place systems for clashes and clearances, addresses connection alignment between systems.

T19—Formwork/shoring, scheduling, and detailing

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Formwork contractor 33-41 11 14

Information obtained from:

Reinforcing bar and tendon schedule, concrete placing general plan, construction schedule correction, and structural review notes.

Task description:

Determines formwork and shoring schedule, synchronizing with placement schedule.

T20—Reinforcement layout of integrated model

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Reinforcing detailer 33-41-11-14

Information obtained from:

Uses reinforcing bar and tendon layout of structural members, batch delivery sequence order, and detailed concrete model.

Task description:

Determines revised reinforcing bar details that addresses pour sequence and breaks and continuity of reinforcing bar where advantageous. Determines reinforcing bar placement at connections and member intersections and identifies laps and reinforcing bar connectors. Considers monolithic model and resolves overlaps.

T21—Reinforcement scheduling

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Reinforcing contractor 33-41 11 14 17

Information obtained from:

Receives reinforcing placement model, formwork and shoring work package, and coordinated construction model from general contractor.

Task description:

Plans reinforcing bar and tendon sequencing and schedule. Reflects pour sequencing and anticipates formwork sequencing.

T22—Concrete finish planning and work packages

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Finish contractor 33-41 11 14

Information obtained from:

Concrete finish layout model, detail concrete model, formwork placement model, and construction coordination model.

Task description:

Integrate and adjust sequencing of concrete formwork and stripping plans to address finish liners or post-stripping procedures.

T23—Distributor delivery schedule

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Reinforcement distributor 33-25 41 11

Information obtained from:

Reinforcing bar and concrete placement schedule, preliminary reinforcing bar placement schedule.

Task description:

Coordinate reinforcement delivery schedule with overall placement schedule.

T24—Placement sequence planning

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Concrete contractor 33-41 11 14

Information obtained from:

Receives construction coordination and schedule corrections, reinforcement delivery schedule, formwork placement model, finish work packages model and connection, and erection review report.

Task description:

Works out pour sequence plan, coordinating with general contractor; includes coordination of concrete deliveries, reinforcement, formwork, concrete finishes, all embeds, and other supplies; updates placement model to reflect this information.

T25—Batch order

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Batch plant 33-41 21 24

Information obtained from:

Receives concrete batch delivery and mixture proportion requirements for project.

Task description:

Determines sources and arranges for admixtures for special performance needs.

T26—Construction coordination and scheduling

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

General contractor 33-41 11 11

Information obtained from:

Brings together all schedules from subcontractors for coordination.

Task description:

Generate construction schedule and coordination model; may relate all models together in four-dimensional simulation. Model includes all preparatory tasks, including shoring, formwork and reinforcement placement, concrete placement, and form stripping.

T27—Site excavation execution

Design phase:

Concrete resource and placement planning 31-40 30 31

Concrete execution 31-40 40 24

Discipline:

Site contractor 33-41-11 14

Information obtained from:

General contractor 33-41 11 11

Task description:

Using latest scheduling report (R17 and EM20) coordinates final site scheduling and logistics tasks for site excavation and fill work, to support concrete placement requirements.

T28—Distributor delivery

Design phase:

Concrete execution 31-40 40 24

Concrete resource and placement planning 31-40 30 31

Discipline:

Reinforcement distributor 33-25 41 11

Information obtained from:

Mill order schedule.

Task description:

Mill delivery, probably staged and in batches according to fabrication order.

T29—Reinforcement fabrication

Design phase:

Concrete resource and placement planning 31-40 30 31

Discipline:

Reinforcing fabricator 33-41 11 14

Information obtained from:

Mill delivery schedule and reinforcing bar layout and delivery sequence, detailed placement model, and mill delivery. Includes post-tensioned materials that, in some cases, may be from a separate organization.

Task description:

Based on lengths, material specifications, and bending requirements; reinforcing bar is fabricated on schedule and delivered to site.

T30—Formwork and shoring execution

Design phase:

Concrete execution 31-40 40 24

Discipline:

Formwork contractor 33-41 11 14

Information obtained from:

Formwork placement model, pour model, and construction reference sequence.

Task description:

Place all shoring needed for current set of pours, place formwork, place liners if needed, and prepare forms for receiving concrete.

T31—Reinforcement and embed placement

Design phase:

Concrete execution 31-40 40 24

Discipline:

Reinforcing contractor 33-41 11 14 17

Information obtained from:

Reinforcement delivery and placement schedule and construction reference schedule.

Task description:

Places reinforcement, including mesh, loose bars, and reinforcing bar cages, as uniquely identified by mark identification. Inserts all embeds and dummy material for block-

outs. (These may be placed by external trades [plumbing or chaises].) Places tendons prior to pours and undertakes tendon cap placement and stressing and cutoffs; undertakes patching of tendon cap embeds.

T32—Concrete placement and breaks

Design phase:
Concrete execution 31-40 40 24
Discipline:
Concrete contractor 33-41 11 14
Information obtained from:
As-built models and schedule from subcontractors including shoring and formwork, reinforcing contractors, and construction reference schedule from general contractor.
Task description:
Prepares shoring and formwork model for current placements; provides dams and edge condition, including all break and joints; carries out concrete placement per current schedule.

T33—Lab testing

Design phase:
Concrete execution 31-40 40 24
Discipline:
Testing agency 33-25 54 00
Information obtained from:
Concrete placing casting cylinders, tendon stressing records, and slab flatness testing.
Task description:
Slump testing, compression tests, flexural tests, and moisture testing.

T34—Curing

Design phase:
Concrete execution 31-40 40 24
Erection phase 31-40-40-14-11
Discipline:
Concrete contractor 33-41 11 14
Information obtained from:
Time of placing, weather conditions, testing agency.
Task description: Testing of current pours, plan for stripping.

T35—Finish concrete

Design phase:
Concrete execution 31-40 40 24
Erection phase 31-40-40-14-11
Discipline:
Finish contractor 33-41 11 14
Information obtained from:
Concrete finish (T22) with formwork placement, formwork sequence, and contractor's construction reference model.
Task description:
Verify liner use during pour, carry out required finish action after form stripping (scheduled in stages).

T36—Prepare actual construction schedule

Design phase:
Concrete execution 31-40 40 24
Discipline:
General contractor 33-41 11 11
Information obtained from:
Actual placement schedule of formwork and reinforcement.
Task description:
Adjusts planned pour sequence schedule with actual batch production. Adjusts production work packets and placement breaks to reflect actions needed on the ground.

T37—Formwork stripping

Design phase:
Erection phase 31-40-40-14-11
Discipline:
Concrete contractor 33-41 11 14
Information obtained from:
Field, meteorologist, testing results.
Task description:
Strip formwork at appropriate level of curing, carry out patching as needed, prepare reusable formwork for next placement.

T38—Prepare as-build model

Design phase:
Erection phase 31-40-40-14-11
Discipline:
General contractor 33-41 11 11 (discipline may vary)
Information obtained from:
Receives as-built information from all subcontractors, including concrete subcontractors.
Task description:
Prepares as-built model to owner specification for pass-off.

(II) NONMODEL INFORMATION EXCHANGE DESCRIPTIONS

The following exchange data refers to the process model and identifies the contents of nonmodel changes and their purpose and general content.

R1—Concrete finishes

Design phase:
Design development 31-20 20 00
Discipline from:
Architect 33-21 11 00
Discipline to:
Finish contractor 33-41 11 14
Information transmitted:
Provide finish samples/specification for concrete finishes.
Typical formats:
Photos and physical samples.

R2—Layout review report

Design phase:
Design development 31-20 20 00
Discipline from:
Structural engineer 33-21 31 14

Discipline to:
Architect 33-21 11 00
Information transmitted:
Provide structural consideration feedback to architect with regard to structural topology, bracing, foundations, member sizes, and other issues associated with the structural aspects of the project. Review process is iterated until an acceptable structural design and project structure is defined.
Typical formats: Marked-up drawings, freehand sketches, and possibly BIM coordination format notes.

R3—Geotechnical data

Design phase:
Design development 31-20 20 00
Discipline from:
Geotechnical engineer 33-21 31 11 11
Discipline to:
Structural engineer 33-21 31 14
Civil engineer 33-21 31 11
Information transmitted:
Provide geotechnical report regarding soil mechanics, moisture flows, and bearing capacities for foundation planning.
Typical formats:
Marked-up site plan showing sample test locations and data.

R4—Weather and curing specifications

Design phase:
Design development 31-20-20-00, construction documentation 31-25 00 00, or both
Discipline from:
Structural engineer 33-21 31 14
Discipline to:
Concrete contractor 33-41 11 14
Information transmitted:
Based on expected weather precipitation, temperature, humidity, and guidelines regarding curing times for various pours based on sample tests and weather conditions.
Typical formats:
In tables or notes.

R5—Structural review notes

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Structural engineer 33-21 31 14
Discipline(s) to:
Architect 33-21 11 00
Reinforcing fabricator 33-41 11 14
Reinforcing detailer 33-41 11 14
Formwork contractor 33-41 11 14
Information transmitted:
Provide structural consideration feedback with regard to structural topology, bracing, foundations, member sizes, reinforcement covering, tendon layouts, and other aspects of overall concrete aspects of project. Reviews may be iterated until bidding.
Typical formats:
Marked up drawings, freehand sketches, and BIM coordination format notes.

R6—Reinforcement correction report

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Reinforcing fabricator 33-41 11 14
Discipline to:
Reinforcement detailer 33-41 11 14
Information transmitted:
Reinforcing clash issues; cover problems on inspected pieces.
Typical formats:
BIM coordination format reports, screen capture, and project locations.

R7—Reinforcement distributor order

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Reinforcing fabricator 33-41 11 14
Discipline to:
Reinforcement distributor 33-25 41 11
Information transmitted:
Bar lists, bar or strand count, lengths, and order numbers.
Typical formats:
Spreadsheets and notes.

R8—Concrete preliminary order

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Concrete contractor 33-41 11 14
Discipline to:
Batch plant 33-41 21 24
General contractor 33-41 11 11
Information transmitted:
Preliminary concrete placement schedule and advance batch plant order.
Typical formats:
Schedule diagrams and Gantt charts.

R9—Connection and erection review report

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Structural engineer 33-21 31 14
Discipline to:
Concrete contractor 33-41 11 14
Information transmitted:
Lists unresolved issues of connection design and reinforcing plans; considers pour sequencing and cross-break continuity. Review placement sequence for loading issues. Reviews may be iterative.
Typical formats:
Marked-up drawings, freehand sketches, and BIM coordination format notes.

R10—Site plan review report

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Civil engineer 33-21 31 11
Discipline to:
Site contractor 33-41 11 14
Information transmitted:
Issues relating current site layout and intentions, dealing with all site issues.
Typical formats:
Annotated drawing or model.

R11—Mill delivery schedule

Design phase:
Concrete execution 31-40 40 24
Discipline from:
Reinforcing bar mill or distributor 33-25 41 11
Discipline to:
Reinforcing fabricator 33-41 11 14
Information transmitted:
Physical delivery of reinforcing bar and mesh according to order.
Typical formats:
Schedule and material delivery.

R12—Batch delivery sequence order

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Concrete contractor 33-41 11 14
Discipline to:
Batch plant 33-41 21 24
Information transmitted:
Concrete mixture proportions and delivery schedules, with quantities.
Typical formats:
Spreadsheets and files of orders, mixtures, and quantities.

R13—Batch delivery report

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Batch plant 33-41 21 24
Discipline to:
Concrete contractor 33-41 11 14
Information transmitted:
Batch mixture proportions, delivery time, and quantity.
Typical formats:
Tabular schedule.

R14—Formwork review comments

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Concrete contractor 33-41 11 14
Discipline to:
Reinforcing contractor 33-41 11 14 17
Formwork contractor 33-41 11 14
Information transmitted:
Review formwork placement plan and any required liners for finishes; schedule preparation tasks.
Typical formats:
Drawings or models with annotations.

R15—Mill delivery schedule

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
Reinforcing contractor 33-41 11 14 17
Discipline to:
Concrete contractor 33-41 11 14
Site contractor 33-41 11 14
Information transmitted:
Reinforcing bar delivery schedule considers whether reinforcing bar is shop- or field-assembled into cages.
Typical formats:
Schedule of reinforcing bar batches and data with (optionally) supporting heat information.

R16—Construction coordination corrections

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
General contractor 33-41 11 11
Discipline to:
Reinforcing detailer 33-41 11 14
Formwork contractor 33-41 11 14
Site contractor 33-41 11 14
Concrete contractor 33-41 11 14
Information transmitted:
Provide spatial coordination issues from clashes and spatial coordination (clashes and connection alignment) from EM.19.
Typical formats:
BIM coordination format,.pdf reports, and marked-up drawings.

R17—Construction schedule corrections

Design phase:
Concrete resource and placement planning 31-40 30 31
Discipline from:
General contractor 33-41 11 11
Discipline to:
Reinforcing contractor 33-41 11 14 17
Finish contractor 33-41 11 14
Formwork contractor 33-41 11 14
Site contractor 33-41 11 14
Information transmitted:
Provide spatial coordination reported (clashes and connection alignment) with discrepancies with four-dimensional schedule considerations from EM.20.
Typical formats:
Schedule markup, drawing markup, screen capture in four-dimensional simulation, BIM coordination format.

R18—Placement and finish discrepancy reports

Design phase:
Concrete execution 31-40 40 24
Discipline from:
Architect 33-21-11-00
Discipline to:
Finish contractor 33-41 11 14
Information transmitted:
Identify from field review the finish and discrepancy issues associated with given concrete placements.
Typical formats:
Marked-up drawings or models and photos.

R19—Reinforcing bar mill certification

Design phase:
Concrete execution 31-40 40 24
Discipline from:
Reinforcing bar mill or distributor 33-25 41 11
Discipline to:
General contractor 33-41 11 11
Information transmitted:
Reinforcing batch numbers and associated heat numbers.
Typical formats:
Tabular report, written or .pdf; could also be spreadsheet.

R20—Final reinforcement delivery schedule

Design phase:
Concrete resource and placement planning 31-40 30 31 or Concrete execution 31-40 40 24
Discipline from:
Reinforcing fabricator 33-41 11- 14
Discipline to:
Concrete contractor 33-41 11 14
Information transmitted:
Bill of materials of reinforcing, with delivery dates and batch information.
Typical formats:
Written bill of materials, spreadsheet report.

R21—Fabricated reinforcement delivery

Design phase:
Concrete execution 31-40 40 24
Discipline from:
Reinforcing fabricator 33-41 11 14
Discipline to:
Reinforcing contractor 33-41 11 14 17
Information transmitted:
Provide reinforcing bar batches and delivery on schedule to site and time adjusted for shop or field assembly of reinforcing bar.
Typical formats:
Tabular schedule associated with piecemark bundles, possibly mill heats.

R22—Placement (pour) samples

Design phase:
Concrete execution 31-40 40 24
Discipline from:
Concrete contractor 33-41 11 14
Discipline to:
Testing agency 33-25 54 00
Information transmitted:
Placing samples for slump and other forms of tests.
Typical formats:
Physical sample.

R23—Placement test results

Design phase:
Concrete execution 31-40 40 24
Discipline from:
Testing agency 33-25 54 00
Discipline to:
Concrete contractor 33-41 11 14
General contractor 33-41 11 11
Structural engineer 33-21 31 14
Information transmitted:
Results from slump and other tests.
Typical formats:
Written report or .pdf of test results.

(III) EXCHANGE MODEL DESCRIPTIONS

EM.1—Architect's mass structural model

Project stage
Design development 31-20 20 00, Construction documentation 31-25 00 00, or both.

Exchange disciplines
Sender: Architecture 33-21 11 00
Receiver(s): Structural engineer 33-21 31 14

Description
Purpose of exchange: Provide structural engineer with base layout to determine structural design. May have previously reviewed project in earlier phases.
Major elements: Includes major structural concrete elements, major load placements, elevators and stair shafts, concrete walls, and foundations. This exchange is iterated until all reinforced concrete aspects are identified and resolved when model is exported as EM.5.
Level of detail: First iteration is conceptual, with approximate dimensions.
Special attributes: Special loads.

Software functionality: export and import
Export: Architectural or design intent building modeling tool.
Import: Structural analysis application typically involves non-model feedback.

Related exchange models
Earlier exchanges between architect and structural engineering are succeeded with contract document (EM.5) for reinforced concrete design.

EM.2—Formwork finishes and detail geometry

Project stage
Design development 31-20-20-00

Exchange disciplines
Sender: Architecture 33-21 11 00
Receiver(s): Concrete contractor 33-41 11 14
Concrete formwork contractor 33-41 11 14
Finish contractor 33-41 11 14

Description
Purpose: To identify formwork requirements for cast-in-place work, including for concrete finishes.
Major elements: Associated finish specification and materials and procedures are available.
Level of detail: Identifies all nonstandard finishes and surface areas affected.
Special attributes: Selected colors and finish type.

Software functionality: export and import
Export: Architectural intent model representing concrete finishes.
Import: Reinforced concrete detailing application that supports modeling and placement of finishes.

Related exchange models
NA

EM.3—Site plan and foundation layout

Project stage
Design development 31-20 20 00

Exchange disciplines
Sender: Civil engineer 33-21 31 11
Receiver(s): Structural engineer 33-21 31 14
General contractor 33-41 11 11
Concrete contractor 33-41 11 14

Description
Purpose of exchange: Site, with general layout of complete facility with concrete improvements and foundation functional model.
Major elements: Base concrete model from EM.1; defines concrete site improvements: outside concrete slabs, retaining walls, and foundations. All outside walls, structural elements, stormwater management flows and rates, and catchments or cisterns.
Level of detail: Sufficient for project spatial coordination.

Software functionality: export and import
Export: Two-dimensional CAD or two-dimensional or three-dimensional building information modeling tool that deals with civil and site development.
Import: Reinforced concrete detailing applications, contractor's site, and civil engineering applications.

Related exchange models
EM.1

EM.4—Mechanical system model

Project stage
Design development 31-20 20 00

Exchange disciplines
Sender: Mechanical engineer 33-21 31 17
Receiver(s): Structural engineer 33-21 31 14
Concrete contractor 33-41 11 14
Reinforcing detailer 33-41 11 14
Reinforcing fabricator 33-41 11 14

Description
Purpose of exchange: Provide placement of major mechanical system components sufficient to define connections, pass-throughs, and other aspects requiring spatial coordination with mechanical system. Also identifies insulation needs and areas to include it. Defines connection and other embeds, pads, and curbs needed for mechanical equipment.
Major elements: Major mechanical elements, steel for connections of external systems and their connections to the structure, ducts and piping to and from mechanical equipment needed for routing. Insulation requirements.
Level of detail: sufficient for layout.

Software functionality: export and import
Export: Various mechanical, electrical, and plumbing modeling applications.
Import: Reinforced concrete detailing applications.

Related exchange models
NA

EM.5—Architect's contract model

Project stage
Construction documentation 31-25 00 00

Exchange disciplines
Sender: Architecture 33-21 11 00
Receiver(s): Structural engineer 33-21 31 14
General contractor 33-41 11 11
Mechanical engineer 33-21 31 17

Description
Purpose of exchange: Provide a variety of users with concrete layout, as iterated and approved by structural engineer as construction document model.
Major elements: Includes all structural concrete elements, load placements, elevators and stair shafts concrete walls, and foundations identified in contract documents.
Level of detail: Concrete is accurately dimensioned, but not detailed, lacking embeds and reinforcing, finishes not addressed.
Special attributes: Retaining walls, foundations, pilings, and special loads.

Software functionality: export and import
Export: Architectural or design intent building modeling tool.

Import: Structural analysis application.

Related exchange models

Earlier exchanges (EM.1) between architect and structural engineer.

EM.6—Structural design model

Project stage

Construction documentation 31-25 00 00

Exchange disciplines

Sender: Structural engineer 33-21 31 14
Receiver(s): General contractor 33-41 11 11
Concrete contractor 33-41 11 14
Site contractor 33-41 11 14
Reinforcing detailer 33-41 11 14

Description

Purpose: Report of detail structural design to determine steel reinforcing sections, lap standard details, and special connections. Optionally provide early mill order for reinforcing and early shoring needs.

Major elements: Reinforced concrete members and reinforcing cross section layouts and spacing requirements; standard details; lap lengths; special connections; concrete strength; steel reinforcing and tendon specifications, including coatings, expansion joints, and post-tensioned tendon placement joints. Includes geophysical data and foundation spatial requirements.

Level of detail: Sufficient for determining detailing to realize project structural requirements, as defined by structural engineer.

Special attributes: Reinforcing bar layout for member sections, reinforcing lap requirements, required concrete joints, major embeds, and cutouts.

Software functionality: export and import

Export: Structural analysis application
Import: Concrete detailing application

Related exchange models

NA

EM.7—Blockout and insulation placement

Project stage

Construction documentation 31-25 00 00, Concrete placement and resource planning 31-40 30 21, or both.

Exchange disciplines

Sender: Mechanical engineering 33-21 31 17
Receiver(s): Concrete contractor 33-41 11 14
General contractor 33-41 11 11

Description

Purpose of exchange: To identify placement of blockouts for pass-through in concrete placement. Also where thermal insulation will go over or within concrete for insulation or vibration

Major elements: Insulation performance and type (that is, rigid or sprayed), all blockouts geometrically defined.

Level of detail: Surface areas addressed and performance criteria.

Special attributes: Insulation specifications.

Software functionality: export and import

Export: Architectural or construction coordination model that includes concrete and mechanical equipment.
Import: Concrete detailing applications.

Related exchange models

NA

EM.8—Preliminary reinforcement detailed model

Project stage

Construction documentation 31-25 00 00

Exchange disciplines

Sender: Reinforcing detailer 33-21 31 14
Receiver(s): Reinforcing fabricator 33-41 11 14
Reinforcing contractor 33-41 11 14 17
Concrete contractor 33-41 11 14

Description

Purpose of exchange: To provide reinforcement layout to all reinforcing disciplines, with consideration to structural requirements and concrete placement.

Major elements: All concrete sizes, all reinforcing and tendon members.

Level of detail: Sufficient for layout.

Software functionality: export and import

Export: Reinforced concrete detailing application.
Import: Reinforcing detailing applications.

Related exchange models

EM.9

EM.9—Detailed integrated reinforcement layout

Project stage

Concrete resource and placement planning 31-40 30 31

Exchange disciplines

Sender: Reinforcing bar detailer 33-21 31 14
Receiver(s): Structural engineer 33-21 31 14
Concrete contractor 33-41 11 14
Reinforcing contractor 33-41 11 14 17
Reinforcing fabricator 33-41 11 14
Reinforcement distributor 33-25 41 11

Description

Purpose of exchange: Integrates placement and reinforcement and tendon layout with both integrated structure and pour sequence (tendons may be a separate model).

Major elements: Reinforcement and tendon items to be associated with pours, all embeds and connection plates, and with pour work packets (all concrete related placing activi-

ties in schedule). All reinforcing bar, mesh, and tendons, properly placed within concrete, with layout of ties, laps, and special connections. May be multiple models, not one.

Level of detail: Full detail.

Software functionality: export and import

Export: Reinforced concrete detailing applications, with reinforcing and tendons, plates, and embeds fully modeled.

Import: Import reinforcing bar into all applications that need to coordinate with its placement: for formwork, concrete contractor, and general contractor.

Exchange likely to be iterated to realize layout based on construction logic.

Related exchange models

NA

EM.10—Structural embeds and plates

Project stage

Concrete resource and placement planning 31-40 30 21

Exchange disciplines

Sender: Reinforcing fabricator 33-41 11 14
Receiver(s): Structural engineer 33-21 31 14

Description

Purpose of exchange: To identify all plates, reinforcing, and embeds for all concrete pieces. Also identify special formwork considerations such as decking for placement and connections. Reviewed by structural engineer. Reinforcing fabricator work may be done by steel fabricator.

Major elements: Steel for internal and external connections; blockouts required for constructability; placement stops (edge-of-slab), mechanical-generated curbs and plates, decking and other permanent formwork; composite materials, if used, are defined.

Level of detail: Fabrication level detailing of reinforced concrete, all components included.

Special attributes: Reinforcing and embed material specifications.

Software functionality: export and import

Export: Concrete detailing applications.
Import: Concrete structural analysis applications.
May be one-way or with nonmodel feedback.

Related exchange models

NA

EM.11—Formwork piece model

Project stage

Concrete resource and placement planning 31-40 30 31

Exchange disciplines

Sender: Formwork contractor 33-41 11 14
Receiver(s): Concrete contractor 33-41 11 14
General contractor 33-41 11 11

Description

Purpose of exchange: To identify formwork attributes.

Major elements: Identification of prefabricated formwork, those requiring fabrication, reuse schedule, associated finish specification, and materials.

Level of detail: Identifies all concrete surfaces and their needed formwork piece assignment or finish process.

Special attributes: Proprietary formwork piece identification.

Software functionality: export and import

Export: Reinforced concrete detailing application that supports modeling and placement of finishes.

Import: Concrete detailing and scheduling application.

Related exchange models

R14

EM.12—Construction resource model

Project stage

Concrete placement and resource planning 31-40 30 21

Exchange disciplines

Sender: General contractor 33-41 11 11
Receiver(s): Site contractor 33-41 11 14
Mechanical engineer 33-21 31 17
Concrete contractor 33-41 11 14
Formwork contractor 33-41 11 14
Reinforcing contractor 33-41 11 14 17
Structural engineer 33-21 31 14

Description

Purpose of exchange: To coordinate cast-in-place concrete with all other building systems for constructability and clash resolution; takes place multiple times throughout the project process. Relies on concrete element objects.

Major elements: All concrete object shapes; reinforcing not included.

Level of detail: All external shape geometry, without reinforcing or other embeds.

Special attributes: Building data owner, piece identifier.

Software functionality: export and import

Export: Concrete detailing application.

Import: Construction management application, supporting detailed spatial coordination in an integrated building model.

Related exchange models

EM.20

EM.13—Site planning model

Project stage

Concrete placement and resource planning 31-40 30 31

Exchange disciplines

Sender: Site contractor 33-41 11 14
Receiver(s): Civil engineer 33-21 31 11

General contractor 33-41 11 11
Concrete contractor 33-41 11 14

Description

Purpose of exchange: To coordinate site development resources, for delivery of concrete, storage areas for reinforcing bar, formwork, other concrete related resources, as reviewed and coordinated with other subcontractors.

Major elements: Verify and review access points; queuing areas, pumping, or lifting requirements and locations; rough schedule of project phases; and logistics changes.

Level of detail: Typically two-dimensional plan layout, possibly three-dimensional in complex site conditions.

Special attributes: Iterated until site plan coordination issues are resolved.

Software functionality: export and import

Export: Contractor's site planning applications.

Import: Many applications that can edit or view site planning layouts.

Related exchange models

NA

EM.14—Detailed concrete model

Project stage

Concrete resource and placement planning 31-40 30 21

Exchange disciplines

Sender: Reinforcing contractor 33-41 11 14 17
Receiver(s): Reinforcing contractor 33-41 11 14 17
Finish contractor 33-41 11 14
Reinforcing detailer 33-41 11 14
Formwork contractor 33-41 11 14
General contractor 33-41 11 11
Structural engineer 33-21 31 14

Description

Purpose of exchange: Provides reinforced concrete detail layout, with all members defined and reinforcing bar placed. Connections to nonconcrete elements: wall systems vertical circulation, mechanical equipment defined. Used for structural review, finish contractor coordination, and schedule coordination.

Major elements: All members, with reinforcing placed for members and internal and external connections and finishes defined.

Level of detail: Fabrication-level layout, complete except for placement sequencing.

Software functionality: export and import

Export: Reinforced concrete detailing application, able to represent reinforcing, tendons, embeds, finishes, and other details.

Import: Applications that can import and use the aforementioned reinforced concrete data.

Related exchange models

NA

EM.15—Reinforcement placement sequence

Project stage

Concrete resource and placement planning 31-40 30 31

Exchange disciplines

Sender: Reinforcing detailer 33-21 31 14
Receiver(s): Formwork contractor 33-41 11 14
Reinforcing fabricator 33-41 11 14
Reinforcing contractor 33-41 11 14 17

Description

Purpose of exchange: Coordinate reinforcement and tendon placement with placement sequence and schedule.

Major elements: All reinforcement and tendon items, embeds, and formwork including formwork for special finishes, blockouts, insulation, to be associated with schedule and placement.

Level of detail: Complete detail; schedule for formwork and reinforcing elements.

Software functionality: export and import

Export: Reinforced concrete detailed model, with definition of placement schedule related to pour sequence.

Import: Construction coordination model applications able to show both model detailing and sequencing.

May be one-way or round trip.

Related exchange models

Is elaboration of EM.9

EM.16—Formwork placement model

Project stage

Concrete placement and resource planning 31-40 30 31

Exchange disciplines

Sender: Concrete formwork contractor 33-41 11 14
Receiver(s): Finish contractor 33-41 11 14
Concrete contractor 33-41 11 11

Description

Purpose of exchange: Define formwork placement plan, which areas use movable formwork, which requires custom work or metal decking, and which need form inserts for patterning; also includes formwork and shoring placement planning and scheduling.

Major elements: Concrete surface areas and their formwork requirements, defined as attributes/annotations, and decking placement.

Level of detail: Conceptual definition of intent; includes scheduling of formwork placement.

Software functionality: export and import

Export: Reinforced concrete detailing application, able to represent reinforcing, tendons, embeds, finishes, and other details.

Import: Applications that can import and use the reinforced concrete data.

Related exchange models
EM.11

EM.17—Finish work package model

Project stage
Concrete placement and resource planning 31-40 30 31

Exchange disciplines
Sender: Concrete contractor 33-41 11 14
Receiver(s): Finish contractor 33-41 11 14
General contractor 33-41 11 11

Description
Purpose of exchange: Define finish plan.
Major elements: The finish plan will be based on the concrete placement and curing plan and concrete pour geometry.
Level of detail: Shop model detail.

Software functionality: export and import
Export: Concrete detailing and finish application.

Related exchange models
NA

EM.18—Final structural design model

Project stage
Concrete placement and resource planning 31-40 30 31

Exchange disciplines
Sender: Structural engineer 33-21 31 14
Receiver(s): General contractor 33-41 11 11

Description
Purpose of exchange: To apply the changes to the structural design based on the feedback from the general contractor and subcontractors regarding constructability and other issues and to provide the complete and final structural design.
Major elements: Input related to pour breaks, curing, and concrete mixture.
Level of development: Issued for construction.

Software functionality: export and import
Export: Structural design physical model, final geometry, and final stiffeners or other features.

Related exchange models
NA

EM.19—Site excavation as-built

Project stage
Concrete execution 31-40 40 24

Exchange disciplines
Sender: Site contractor 33-41 11 14
Receiver(s): General contractor 33-41 11 11

Description
Purpose of exchange: To document final site modifications made for concrete work, as carried out. Coordination with all reinforced concrete building information model roles for placement, queuing, access points, and temporary storage. Also, all site condition details for landscaping, walk concrete paving, and other later works.
Major elements: Cut and fill, as-built concrete subterranean elements, walkways, and any exterior retaining walls.
Level of detail: As-built placement and as required by owner.

Software functionality: export and import
Export: Detailed site planning and civil works application.
Import: Coordination with all applications used by reinforced concrete building information model roles.

Related exchange models
All previous site models.

EM.20—Construction reference schedule

Project stage
Concrete placement and resource planning 31-40 30 31

Exchange disciplines
Sender: General contractor 33-41 11 11
Receiver(s): Concrete contractor 33-41 11 14
Finish contractor 33-41 11 14
Structural engineer 33-21 31 14
Reinforcing contractor 33-41 11 14 17
Formwork contractor 33-41 11 14
Site contractor 33-41 11 14

Description
Purpose of exchange: Coordinate layout of all systems for clashes and coordinate schedule of installation, especially with formwork and finishing tasks; optionally a four-dimensional configurator, also used to verify coordination with mechanical systems and architectural intent.
Major elements: All major systems: structure; mechanical, electrical, and plumbing; and architectural detailing interfacing with concrete work for clash detection and coordination. Concrete placement and discrepancy report.
Level of detail: Full detail for concrete finishes and formwork.
Special attributes: Concrete finishing spaces.

Software functionality: export and import
Export: Concrete detailing application.
Import: Construction management application, supporting detailed spatial coordination and scheduling of all project systems in an integrated building model.

Related exchange models
NA

EM.21—Formwork as placed model

Project stage
Concrete execution 31-40 40 24

Exchange disciplines
Sender: Formwork contractor 33-41 11 14
Receiver(s): General contractor 33-41 11 11
Concrete contractor 33-41 11 14
Reinforcing contractor 33-41 11 14 17
Reinforcing fabricator 33-41 11 14 17

Description
Purpose of exchange: Fully coordinate formwork and shoring schedule with general contractor.

Major elements: Monolithic model of concrete; all planned pour breaks; all embeds, reinforcement, and tendons; areas used for shoring and concrete placement; all metal and other decking, updated frequently by on-the-ground status reporting.

Level of detail: Includes all concrete tasks, pour breaks.

Software functionality: export and import

Export: Reinforced concrete detailing application, able to represent reinforcement, tendons, embeds, finishes, and other details.

Import: Integrate with project scheduling applications.

Related exchange models
NA

EM.22—Actual placement submittals

Project stage
Concrete execution 31-40 40 24

Exchange disciplines
Sender: Concrete contractor 33-41 11 14
Receiver(s): General contractor 33-41 11 11

Description
Purpose of exchange: To record the actual pour breaks versus those planned for archival documentation and planning.

Major elements: Concrete elements, actual pour breaks, and added reinforcing.

Level of detail: Reinforcing, pour break geometry, any bonding agents, flatness tests, and stress records. Submittal records noted for cross reference to model as they are posted.

Software functionality: export and import
Export: Construction management applications that can track concrete placement progress, including all components of reinforced concrete and integrated with schedule information.

Import: Scheduling or reporting application.

Related exchange models
NA

EM.23—Reinforcement as-built

Project stage
Erection phase 31-40 40 14 11

Exchange disciplines
Sender: Reinforcing contractor 33-41 11 14
Receiver(s): Concrete contractor 33-41 11 14
General contractor 33-41 11 11

Description
Purpose of exchange: Document all changes to the reinforcing bar, post-tensioning specification, placement sequence adjustments due to installation and tensioning operations; report changes to testing agency.

Major elements: Reinforcing, including mesh and reinforcing bar, tensioning ducts, cables and anchors, and monolithic concrete structure.

Level of detail: As required by owner.

Special attributes: Final tensions in cables, specifications on finishing, and waterproofing on tendon anchors.

Software functionality: export and import
Export: Reinforced concrete detailing applications.
Import: Agreed to as-built delivery model to owner.

Related exchange models
Uses details from EM.9.

EM.24—Client as-built model

Project stage
Erection phase 31-40 40 14 11

Exchange disciplines
Sender: General contractor 33-41 11 11
Receiver(s): Owner/client 33-55 21 00

Description
Purpose of exchange: To hand over as-built model of project to client for use in facility management, operations and maintenance, and for later remodeling.

Major elements: As specified in contract.

Level of detail: As specified in contract.

Special attributes: As required.

Software functionality: export and import
Export: The model type defined by owner for the as-built delivery requirement.

Import: Client facility management program.

Related exchange models
NA