

## Organizing a Local Bridge Design Contest Using the Bridge Designer 2016

### A. Introduction

The Bridge Designer 2016 software provides a realistic, hands-on introduction to engineering through the design of a steel highway bridge.

To design a bridge, the user must do the following:

- (1) Using the Design Project Setup Wizard, select a Bridge Design Project—a unique set of initial constraints (span length, height, support configuration, and load case).
- (2) On the Drawing Board, design a bridge that:
  - passes a simulated load test without collapsing; and
  - costs as little as possible.

Given this format, the Bridge Designer can be used effectively for local contests in which students compete to *design the lowest-cost bridge*.

### B. Contest Formats

There are two possible formats for local contests:

- **Local contests based on *all* possible Bridge Design Projects.** In this format, contestants are permitted to use *any* span length, elevation, support configuration, and load case offered by the Bridge Designer software.
- **Local contests based on a *single* Bridge Design Project.** In this format, participants are assigned *one* specific bridge length, height, support configuration, and load case. This type of contest can be facilitated by using a Local Contest Code (see below).

### C. Local Contests based on all possible Bridge Design Projects

Use this format if you want your contestants to be able to design a bridge using *any* of the 392 different Bridge Design Projects offered by the Bridge Designer 2016—i.e., *any* span length, deck elevation, support configuration, and load case. This contest format allows for a truly open-ended design experience and provides contestants with much broader opportunities to explore design alternatives and demonstrate creativity.

The disadvantage of this format is that it can only be used one time with a given population of students. If a contest in this format is implemented more than once, optimal and near-optimal bridge designs will probably be available from students who participated in previous contests.

Such designs are also often posted on the Internet. As such, this contest format is best suited for a short-term project conducted in a controlled setting (e.g., a school computer lab), where contestants do not have an opportunity to “research” others’ designs on the internet.

To run a local contest based on all possible Bridge Design Projects, the Contest Organizer should provide the following information to contestants:

- Start and end dates for the contest.
- Recognition or prizes that the winners will receive.
- Instructions for accessing, downloading, and installing the Bridge Designer 2016 at <http://bridgedesigner.org/download/>
- Instructions for designing a bridge with the Bridge Designer 2016:
  - You may use *any* available Bridge Design Project.
  - The design objectives are to (1) pass the simulated load test and (2) minimize cost.
  - Save your best design as a .bdc file, using the following format: ***YourName.bdc***
- Instructions for submitting designs. (See below.)

Our *recommended* process for submitting designs is as follows:

- At the end of the contest period, contestants send the .bdc file for their best design to the Contest Organizer as an e-mail attachment. The SUBJECT: of the e-mail message should be the *cost* of the design (for example, **Subject: \$123,456.78**).
- Before naming the winners, the Contest Organizer must verify all potential winners’ design submissions by opening each .bdc file in the Bridge Designer, verifying that it passes the load test, and verifying that the contestant’s self-reported cost is correct. The Contest Organizer should use the contestant’s self-reported cost in the SUBJECT: line as the basis for deciding which design submissions to verify. (Note that, if the Contest Organizer does not require students to report their own costs, the Organizer will need to manually verify 100% of the design submissions.)

To add interest to the competition, the Contest Organizer may choose to provide an informal scoreboard to record the contestants’ current best scores while the competition is in progress.

## **D. Local Contests based on a single Bridge Design Project**

This format is particularly useful for three situations:

1. Competitions that must be conducted within a very limited period of time—because all contestants will begin their designs from the same starting point.
2. Competitions that will be repeated on a recurring basis (e.g., annually)—because a different Bridge Design Project can be used for each successive iteration of the competition.
3. Competitions that will be conducted over a very long period of time—because the other contest format (based on all possible Bridge Design Projects) would give contestants ample time to research and acquire others’ optimal design solutions.

It should be assumed that optimum or near-optimum designs created with the Bridge Designer 2016 are readily available on the internet. By specifying a Bridge Design Project that is

substantially different from the ones used in previous years, the Contest Organizer can “level the playing field” for the current contest. The Bridge Designer offers **392** different Bridge Design Projects, so many recurring contests can be run without duplicating projects.

To run a local contest based on a single Bridge Design Project, the Contest Organizer should choose a Bridge Design Project and create a corresponding Local Contest Code, based on the instructions provided in **Appendix A** of this document.

The Contest Organizer should then provide the following information to contestants:

- Start and end dates for the contest.
- Recognition or prizes that the winners will receive.
- Local Contest Code (see Appendix A)
- Instructions for accessing, downloading, and installing the Bridge Designer 2016 at <http://bridgedesigner.org/download/>.
- Instructions for designing a bridge with the Bridge Designer 2016:
  - At startup, when prompted for a Local Contest Code, enter the six-character code provided. This will automatically configure the software for the selected Bridge Design Project (span length, height, support configuration, and load case). This process ensures that all contestants will use the designated Bridge Design Project for their designs.
  - Design a bridge. The design objectives are to (1) pass the simulated load test and (2) minimize cost.
  - Save your best design as a .bdc file, using the following format: ***YourName.bdc***
- Instructions for submitting designs. (See below.)

Our recommended process for submitting designs is as follows:

- At the end of the contest period, contestants send the .bdc file for their best design to the Contest Organizer as an e-mail attachment. The SUBJECT: of the e-mail message should be the *cost* of the design (for example, **Subject: \$123,456.78**).
- Before naming the winners, the Contest Organizer must verify all potential winners’ design submissions by opening each .bdc file in the Bridge Designer, verifying that the design is based on the correct Bridge Design Project, verifying that it passes the load test, and verifying that the contestant’s self-reported cost is correct. The Contest Organizer should use the contestant’s self-reported cost in the SUBJECT: line as the basis for deciding which design submissions to verify. . (Note that, if the Contest Organizer does not require students to report their own costs, the Organizer will need to manually verify 100% of the design submissions.)

To add interest to the competition, the Contest Organizer may choose to provide an informal scoreboard to record the contestants’ current best scores while the competition is in progress.

**Good luck!**

## **Appendix A**

### **Bridge Design Projects and the Local Contest Code**

A **Bridge Design Project** consists of two components—the **load case** and the **site configuration**. There are four available load cases and 98 available site configurations. When a local contest organizer requests to set up a local contest, that request should include:

- The desired load case (specify **Load Case A, B, C, or D**)
- The desired site configuration (specify **Site Configuration #1 - #98**)

A **Local Contest Code** consist of six characters:

- Three letters, which can be anything you want. These are intended to uniquely identify your local contest; e.g., FHS for Fairview High School.
- Two digits, which represent the Site Configuration
- One letter (A, B, C, or D), which represent the Load Case.

For example, if your Local Contest Code is “FHS38B”, then your Fairview High School local contest will be using Site Configuration #38 and Load Case B. Local contest participants must know their Local Contest Code in order to enter the local contest; however, it is not necessary for contestants to know the specific load case and site configuration which are being used in the local contest. At start-up, the Bridge Designer software will prompt the user for the Local Contest Code and, based on that code, will automatically configure itself for the correct load case and site configuration.

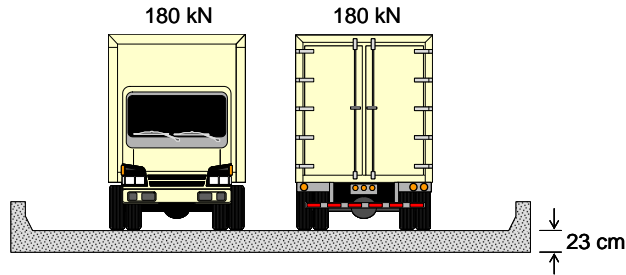
### **Some Considerations for Selecting a Load Case and Site Configuration**

1. In general, a greater *deck height* (i.e., a longer span) will result in a more complex and challenging design. Thus, consider using a lower deck height for younger students or for projects that must be completed in a limited period of time.
2. Site configurations that include *cable anchorages* offer opportunities to explore many unique and interesting bridge types—suspension bridges and cable-stayed bridges, for example. Consider using cable anchorages as a stimulus for contestants’ development of creative design concepts. It is important to note that the inclusion of cable anchorages in the site configuration adds to the total cost of the bridge design, regardless of whether the anchorages are actually used.
3. In deciding on a load case, recognize that the weight of the concrete deck is a *static load*—it doesn’t move—while the weight of the truck is a *moving load*. In general terms, load cases with relatively larger moving load and relatively smaller static load tend to be somewhat more challenging. The moving load will cause the internal force in some structural members to vary considerably—sometimes from tension to compression and vice versa—as the truck crosses the bridge. The design of members subjected to load reversals is somewhat more difficult than the design of members subjected to tension alone or compression alone. Thus, Load Case D will tend to be the most challenging, while Load Case A will tend to be the most straightforward.

## Load Cases

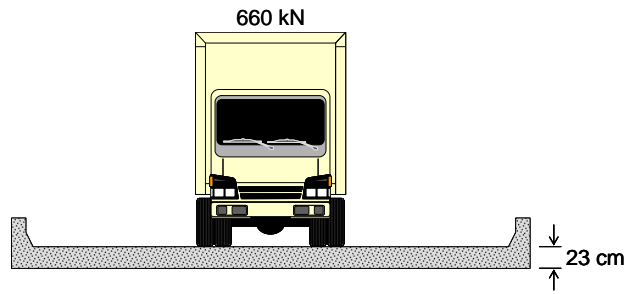
### Load Case A:

- Medium-strength concrete deck (*heavier but less expensive than high-strength concrete*)
- Standard 180 kN H20-44 truck loading in two lanes



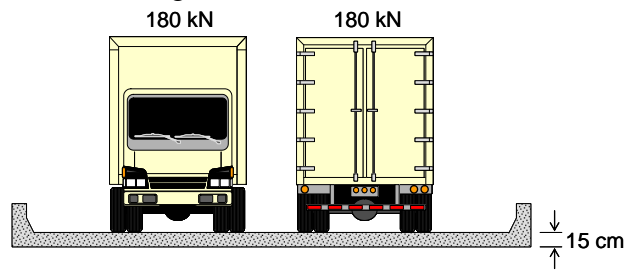
### Load Case B:

- Medium-strength concrete deck (*heavier but less expensive than high-strength concrete*)
- One 660 kN permit loading on the bridge centerline



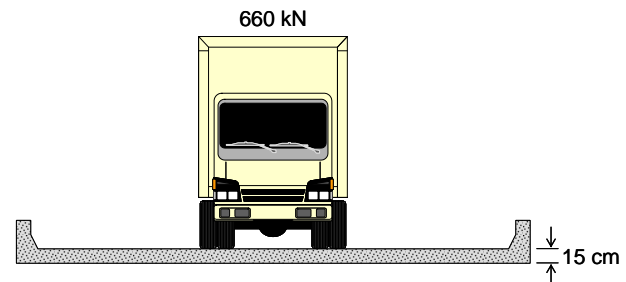
### Load Case C:

- High-strength concrete deck (*lighter but more expensive than medium-strength concrete*)
- Standard 225 kN truck loading in each of the two lanes



### Load Case D:

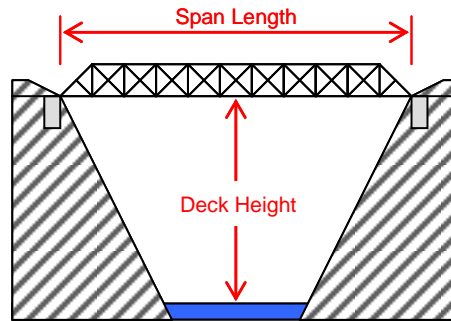
- High-strength concrete deck (*lighter but more expensive than medium-strength concrete*)
- One 480 kN permit loading on the bridge centerline



## Bridge Site Configurations

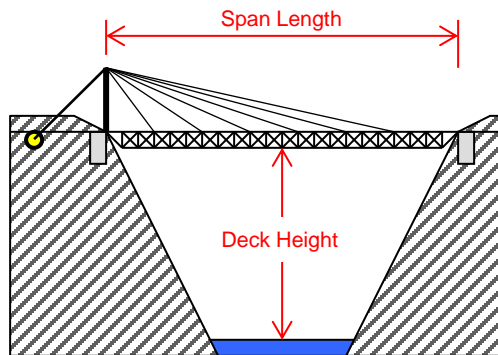
### Standard Abutments

Site Config. #	Deck Height (meters)	Span Length (meters)
01	24	44
02	20	40
03	16	36
04	12	32
05	8	28
06	4	24
07	0	20



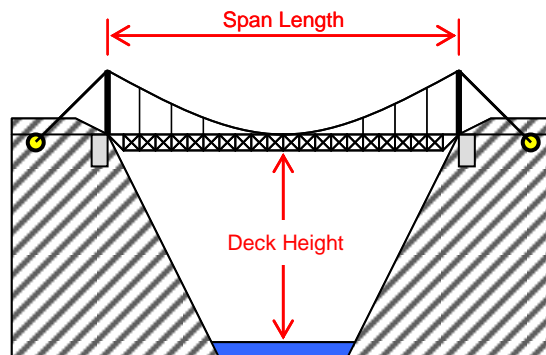
### Standard Abutments with One Cable Anchorage

Site Config. #	Deck Height (meters)	Span Length (meters)
08	24	44
09	20	40
10	16	36
11	12	32
12	8	28
13	4	24
14	0	20



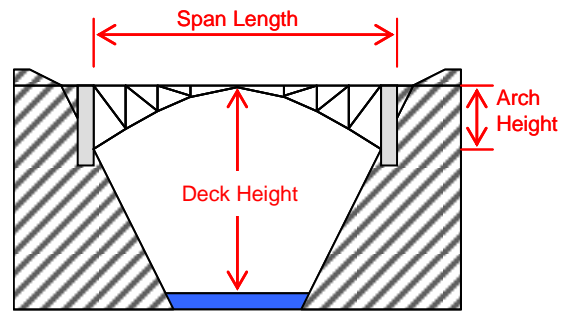
### Standard Abutments with Two Cable Anchorages

Site Config. #	Deck Height (meters)	Span Length (meters)
15	24	44
16	20	40
17	16	36
18	12	32
19	8	28
20	4	24
21	0	20



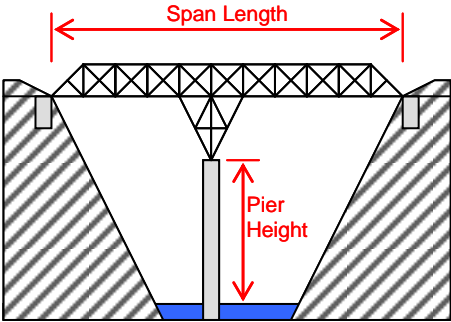
## Arch Abutments

Site Config. #	Deck Height (meters)	Span Length (meters)	Arch Height (meters)
22	24	40	4
23	24	36	8
24	24	32	12
25	24	28	16
26	24	24	20
27	24	20	24
28	20	36	4
29	20	32	8
30	20	28	12
31	20	24	16
32	20	20	20
33	16	32	4
34	16	28	8
35	16	24	12
36	16	20	16
37	12	28	4
38	12	24	8
39	12	20	12
40	8	24	4
41	8	20	8
42	4	20	4



**Standard Abutments with Pier**

Site Config. #	Deck Height (meters)	Span Length (meters)	Pier Height (meters)
43	24	44	0
44	24	44	4
45	24	44	8
46	24	44	12
47	24	44	16
48	24	44	20
49	24	44	24
50	20	40	0
51	20	40	4
52	20	40	8
53	20	40	12
54	20	40	16
55	20	40	20
56	16	36	0
57	16	36	4
58	16	36	8
59	16	36	12
60	16	36	16
61	12	32	0
62	12	32	4
63	12	32	8
64	12	32	12
65	8	28	0
66	8	28	4
67	8	28	8
68	4	24	0
69	4	24	4
70	0	20	0





## Standard Abutments with Pier and Two Cable Anchorages

Site Config. #	Deck Height (meters)	Span Length (meters)	Pier Height (meters)
71	24	44	0
72	24	44	4
73	24	44	8
74	24	44	12
75	24	44	16
76	24	44	20
77	24	44	24
78	20	40	0
79	20	40	4
80	20	40	8
81	20	40	12
82	20	40	16
83	20	40	20
84	16	36	0
85	16	36	4
86	16	36	8
87	16	36	12
88	16	36	16
89	12	32	0
90	12	32	4
91	12	32	8
92	12	32	12
93	8	28	0
94	8	28	4
95	8	28	8
96	4	24	0
97	4	24	4
98	0	20	0

