Team DVCK

ABVE Instruction Manual

Updated May 2024

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Bridge Assembly

The ABVE comes with two styles of bridges students can assemble: the Truss Bridge and the Suspension Bridge. This section covers assembling the bridges and how to use them properly during tests.

The Truss Bridge

Connectors and Members

The Truss Bridge kit comes with two styles of members: short members and long members. The Truss Bridge kit also comes with connectors allowing users to join the members together to build structures.

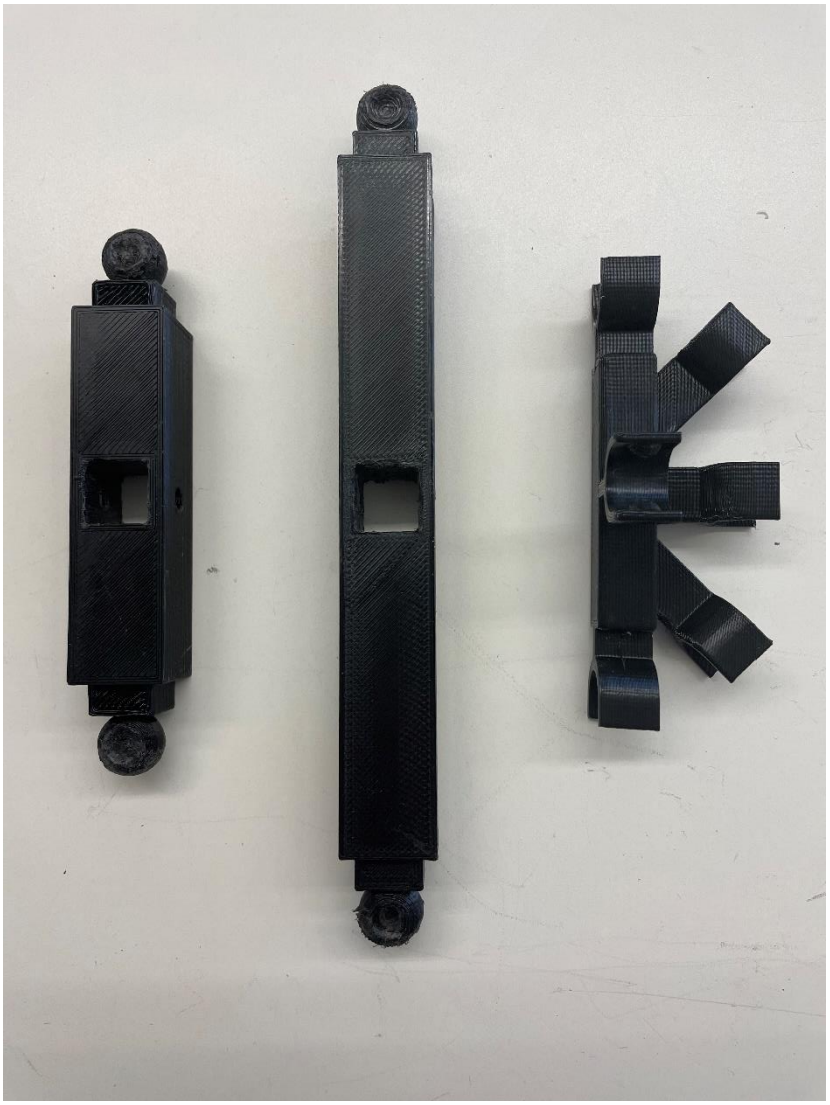


Figure 1: From left: Short Member, Long Member, Connector

The members and connectors join together with a simple snapping mechanism. The ends of the members are fitted with spherical joints with small dimples on each side. On the other hand, the inside walls of the “claws” of the connectors have two raised bumps.

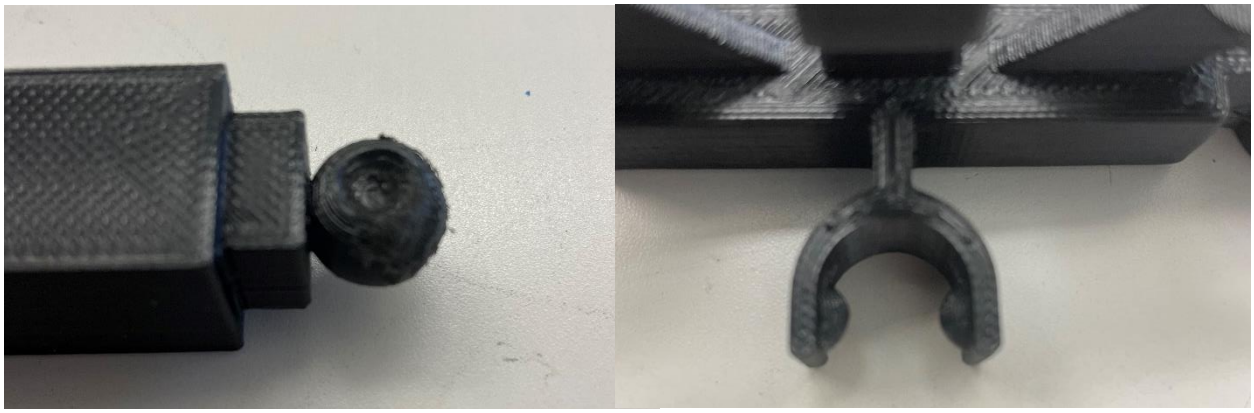


Figure 2. Left: Close-up of spherical joint with indent shown. Right: close-up of connector joint with raised bumps shown.

Joining the Members with Connectors

The connectors and members are joined by aligning the dimples on the spherical joints with the bumps on the inside walls of the connector. The user should angle the member with respect to the member slightly so that one of the dimples on one side of the spherical joint is lined up with one of the bumps on the connector. Then, the user should push the spherical joint down onto the connector joint and forward into the connector slightly so that the spherical joint fits well inside the connector. **WARNING: TOO MUCH FORCE WHEN JOINING MEMBERS TO CONNECTORS CAN CAUSE DAMAGE OR BREAK THE PIECES. NOT MUCH FORCE IS REQUIRED IF DONE CAREFULLY.**

Figure 3. Fitting a bridge member to a connector.

Making Bridges

More members can be added to the same connector in this way. Each connector has five (5) joints, so a total of five members can be added to a single connector. To form three-dimensional truss bridges, the short members should be fitted to the connectors horizontally and vertically while the long members attach diagonally to form the triangular support structure. Then, more short can attach across each side of the truss to make a three-dimensional bridge.

Figure 5. Short and Long members attached to connectors to form triangle.

Figure 4. Example completed structure using the Truss Bridge kit.

The Truss Bridge kit is designed to form three (3) unique trusses: a Howe Truss, a Warren Truss, and a Pratt Truss. However, its modular design makes it possible to form other structures as well so users can get creative! **WARNING: THE TRUSS BRIDGE IS DESIGNED TO SUPPORT UP TO 5KG OF MASS. DO NOT EXCEED THIS LOADING LIMIT.**

The Suspension Bridge

The Suspension B ridge is assembled similarly to the Truss Bridge, with members and its own connectors joining in the same way. However, the Suspension Bridge members also have fishing line tied to them with a small hook attached. The fishing line comes in long, medium, and short string lengths. Assembled properly, the members with the longest pieces of string should be on each end, then the medium length strings, and the shortest in the middle.

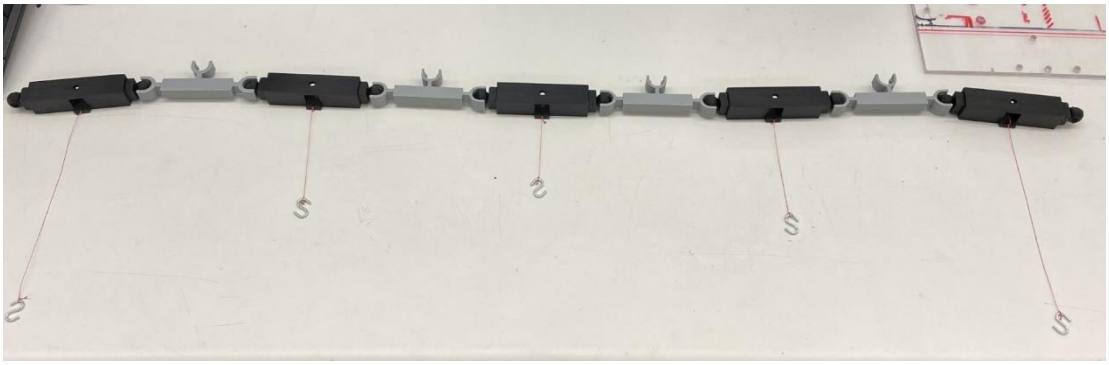


Figure 6. Photograph of assembled side of suspension bridge with fishing line and hooks shown in correct order.

Each side of the suspension bridge should be assembled, with more members then joining across so that the bridge looks like a ladder.

Figure 7. Partially assembled suspension bridge not yet attached to main cable.

Attach the suspension bridge towers to the Support Structure and then hang the two chains across them.

Figure 8. Chains suspended between suspension bridge towers.

Finally, attach the suspension bridge to the chains by sliding the hooks through the chain links. Making sure that the hooks are spaced evenly apart for best results.

Figure 9. Fully assembled Suspension Bridge kit.

Tower Assembly

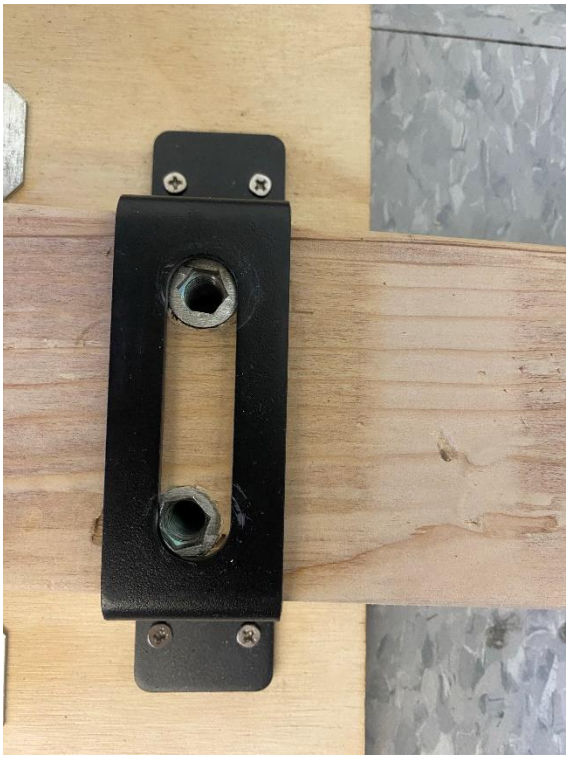
The ABVE is equipped with towers designated for the installation of both the bridge and vibration subsystems. This section delineates the procedures for assembling the provided testing towers.

Setup

Disassembled Product

The disassembled product will include two towers, designated as right and left, along with a sliding bar featuring four threaded inserts. Additionally, the package will contain four square bolts, four washers, and a wrench for the purpose of securely fastening and tightening the bar.

Fasten Sliding Bar to Towers



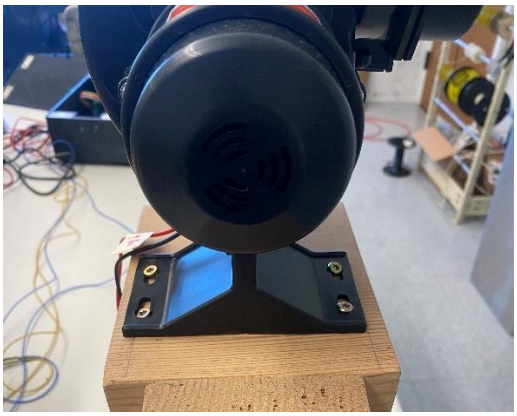
To secure the sliding bar to the towers, simply align the threaded inserts to the opening on the 2x4 fastener (depicted in black), then use the provided wrench to fasten the bar to the tower.

Assembled Product

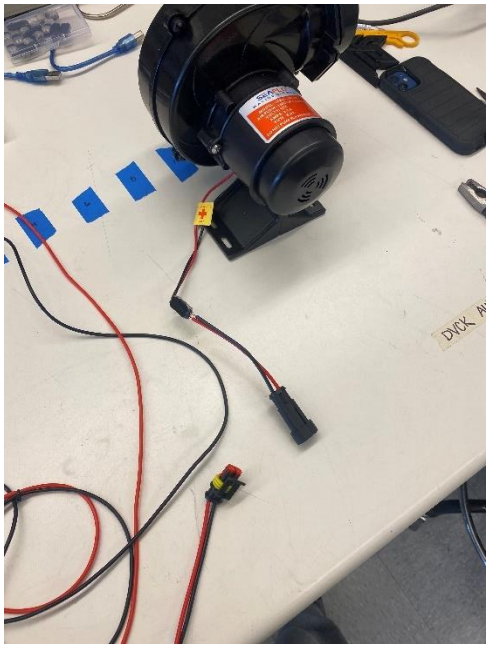
Fan Tower Assembly and Connection

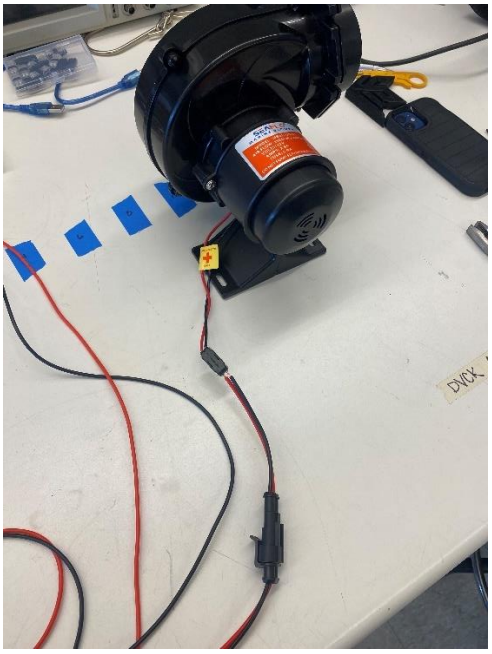
The ABVE incorporates a fan tower engineered to deliver wind simulation to the suspension bridge. This feature is governed by the system microcontroller and programmed to operate in a pulsating manner, activating for 5 seconds followed by a 2-second interval of inactivity, cycling continuously.

Features



Using a drill, you have the option to remove the fan from the subsequent tower if desired. Use a drill to loosen the screws to remove the fan from the tower. We recommend leaving this attached unless you face storage issues.





Use the male/female plugs to connect the fan to the electrical housing.

Fully Assembled Fan Tower

User Interface

Display

The ABVE system includes a screen display that presents real-time data and system notifications directly to the user. This interactive component enhances the system's usability by providing immediate access to vital information.

Features

Real-Time Data Visualization: The screen is designed to display frequency and force readings simultaneously, allowing users to monitor the bridge's condition in real-time. This instant feedback is essential for immediate assessments and responsive decision-making.

Error Notifications: The screen displays operational data and ensures data integrity. Equipped to show error messages, it's particularly useful when there may be data logging issues with the MicroSD Card. The screen will alert users to writing errors, ensuring that potential issues are addressed promptly and data integrity is maintained.

User-Friendly Interface: The display's clear and concise presentation of data ensures that all information is easily understandable, which is critical for routine monitoring and emergency management.

MicroSD Card

The ABVE system incorporates a MicroSD Card function to log frequency and force readings efficiently. This feature simplifies data management and supports thorough analysis, enhancing the monitoring system's functionality and user experience.

Features

Data Format: Data is saved in a universally compatible CSV (Comma-Separated Values) format, ensuring seamless transfer and analysis with spreadsheet software such as Microsoft Excel. This format facilitates the easy transfer, viewing, and analysis of data.

Detailed Record Keeping: The CSV file includes comprehensive readings that detail the frequency of measurements, total force exerted on the entire bridge, and force measurements of specific bridge members as selected by the user. This allows for thorough monitoring and analysis of the bridge’s structural integrity.

Setup

Insertion into Adapter: To begin data logging, the MicroSD Card must be inserted into the designated slot on the adapter located within the electrical housing of the ABVE system. This setup is straightforward and user-friendly, ensuring data logging begins without complications.

Data Access: After data collection, the MicroSD Card can be removed from the ABVE system and inserted into a MicroSD or standard SD Card slot on a personal computer. This flexibility makes it easy to access and analyze the logged data. Users can open the CSV file on their computer to review the force readings, create graphs, and conduct further analysis.

Force Sensor

The ABVE system includes force sensors designed to monitor the forces exerted on the bridge. These tools are essential for assessing structural integrity and ensuring optimal maintenance and safety.

Features

Total Force Measurement: The sensors can determine the cumulative force exerted on the entire bridge, providing a comprehensive view of the structural load.

Individual Member Analysis: Besides total force measurement, the sensors can assess the force on each specific bridge member. This feature is crucial for pinpointing the bridge structure's stress concentration areas and potential vulnerabilities.

Setup

Quantity and Placement: The system includes three force sensors. Two of these sensors are fixed and should be attached at each end of the bridge. These stationary sensors measure the total force exerted across the entire bridge.

Installation Instructions: Installing the sensors is straightforward. Insert the side marked with an image into the cutout on the bridge member. It is vital to ensure that the arrow on each sensor points downwards, aligning with the direction of the net force expected to act on the bridge.

Movable Sensor: The third sensor is designed for flexibility and can be relocated as needed. It is intended to analyze individual bridge members in detail. Users can select a specific member for monitoring by sliding the sensor into the corresponding member's slot.

Taring Button: The ABVE system features a single push button that controls the taring of all sensors. This central taring function is essential for resetting the sensors to zero. It is particularly useful if any sensor shows a reading immediately after being slotted into a member's cutout. Pressing this button ensures that all sensors are calibrated to zero before taking new measurements, providing accuracy and reliability in data collection.

Vibration Control

The ABVE can create vibrations onto the bridge itself using speakers on both sides of the bridge. Just by the turn of a knob, you will be able to generate vibrations to simulate earthquakes on real-life bridges.

Features

Turning on the speakers by switching the button to the on position the speakers will start vibrating at the set 10 Hz signal.

A potentiometer is connected to the signal generator, which increases or decreases the amount of Hz the speaker vibrates to. The minimum Hz is 10 Hz, while the maximum is 450 Hz.