COLOR KINETICS CK Application Notes

Vibration

Introduction

It is well documented that Color Kinetics fixtures are suited for vibration-prone environments. Virtually no electronic devices, however, are capable of withstanding accelerations exerted by the most extreme environments without adequate planning and protection. So as to better guide the specification of Color Kinetics products for such hostile environments, this document details the parameters used in Color Kinetics vibration testing procedures and distinguishes circumstances where special attention to vibration should be paid. Please keep in mind while reading this document that a structural engineer should always be consulted to specify or locate product where vibration is a concern.

Vibration Testing Procedures

Vibration tests are performed to assess the ability of products to withstand the accumulated effects of stress induced by broad-band random vibration and reveal resulting mechanical weakness and degradation.

Color Kinetics tests against failures resulting from continuous random vibrations for all products and from continuous sinusoidal vibrations for some specific products. The discrepancy exists because, while sinusoidal waveforms are common in standard applications, random vibrations can cause much larger accelerations, resulting in much greater danger to Color Kinetics products.

Vibration Standards

Color Kinetics uses Mil-Std 810F, Random Vibration 7.698g, as the baseline vibration specification for assessing product viability. To put the severity of this test condition in perspective, the United States Department of Defense, which developed the Mil-Std 810, applies this standard (ASD[1] of 7.698g) to electronics designed for airplanes, tanks, and other military vessels. For some products, the design intent necessitates more or less stringent environmental testing procedures.

As a general rule, Color Kinetics products can be broken down into the following categories based on vibration test intensity:

[1] Acceleration Spectral Density (ASD)

Random: 5.44g	Random: 7.698g	Random: 10g
Power Data Supplies	Data Enablers Indoor Fixtures Controllers Some Outdoor Fixtures	Some Outdoor Fixtures

Extreme Vibration Environments

Due to the stringent standards to which Color Kinetics products are designed and tested, vibration is rarely an issue. Several environmental categories, however, can see continuous vibration waveforms that near or exceed the test standards outlined above. These environments are dangerous enough that a structural engineer must determine actual installation parameters and interface with Color Kinetics Applications Engineering Group for the products to qualify under warranty conditions. A few examples are listed below.

Transportation Structures	Vehicles	Proximity to Other Vibration Sources
Bridges/Spans	Watercraft	Generators
Railroads/Subways	Aircraft	Vehicles
Large Roads	Trucks	
	Trains	
	Elevator cars	

Application Specific Vibration Specifications

A multitude of factors can influence the intensity and frequency of vibration at any time or location. Therefore, it is especially important that a structural engineer perform critical evaluations of exact application circumstances. Such localized analysis is the only means of obtaining necessary data for the specification of Color Kinetics system components and appropriate damping measures.

The severity of induced accelerations experienced in extreme vibration environments makes the analysis of application specific data all the more important. A prominent example of such analysis and resultant data is explored below.

Ben Franklin Bridge Case Study

The Ben Franklin Bridge is a multi-deck, car and train span located in Philadelphia, PA. Shown below are waveforms measured over different times and fixture/PDS mounting locations.

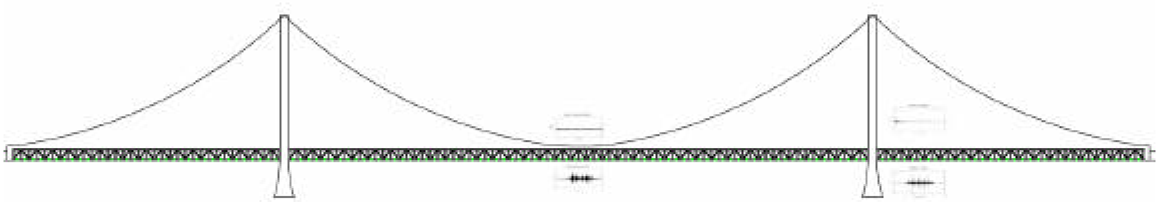

Figure 1: Ben Franklin Bridge representation

The first waveform (Figure 2) is a fine example of steady state vibrations for the specific PDS/fixture location on this bridge. Taken from the base of the East Tower during normal traffic flow, vibration amplitudes (Grms) average around 1g and are fairly constant. It is worth noting that the location of the test was adjacent the train deck, so recorded car traffic vibrations were likely smaller than those experienced on the car deck. For a different bridge or mounting location, steady state car vibrations could be much higher.

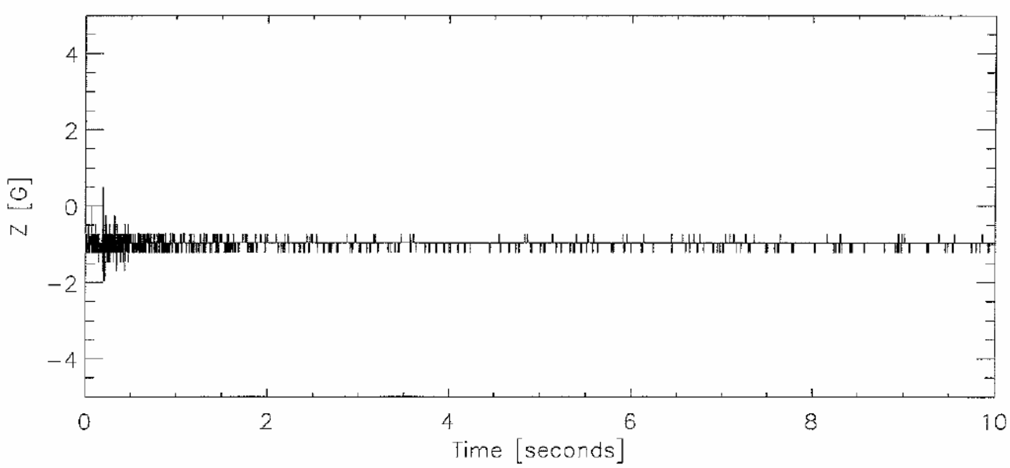

Figure 2 – Sample 6: East tower, normal traffic

Figure 3 shows the waveform measured as a four-car train passed the fixture/PDS at the same East Tower location as in Figure 1. As is obvious from the graph, the vibrations present at this location are far more vicious as a train passes than during normal traffic conditions. The vibrations are so intense that the measured acceleration exceeds 20g.

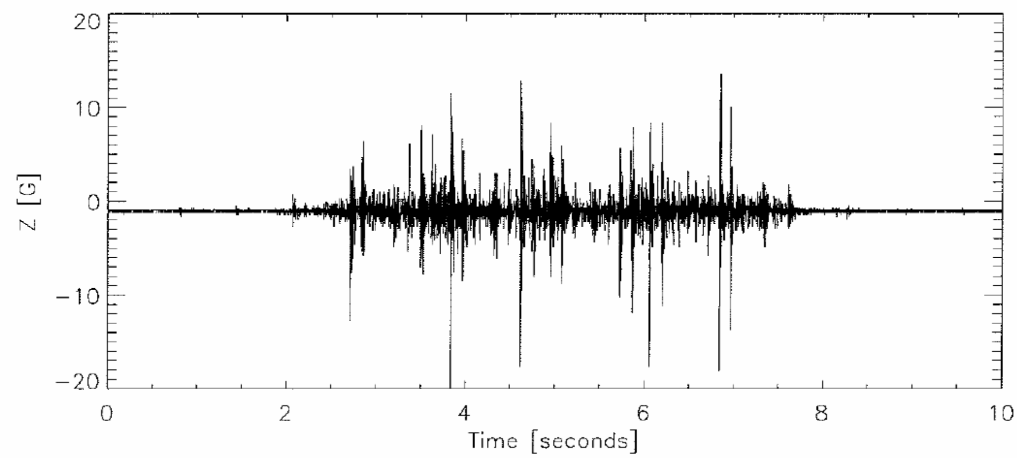

Figure 3 – Sample 7: East tower, 4-car train

Figure 4 depicts the vibrations of another four-car train but this time, measured at the mid-span of the bridge. The discrepancy between the two waveforms is clear, and further supports the notion that vibrations which occur in applications are dependent upon specific location and time, in addition to other factors.

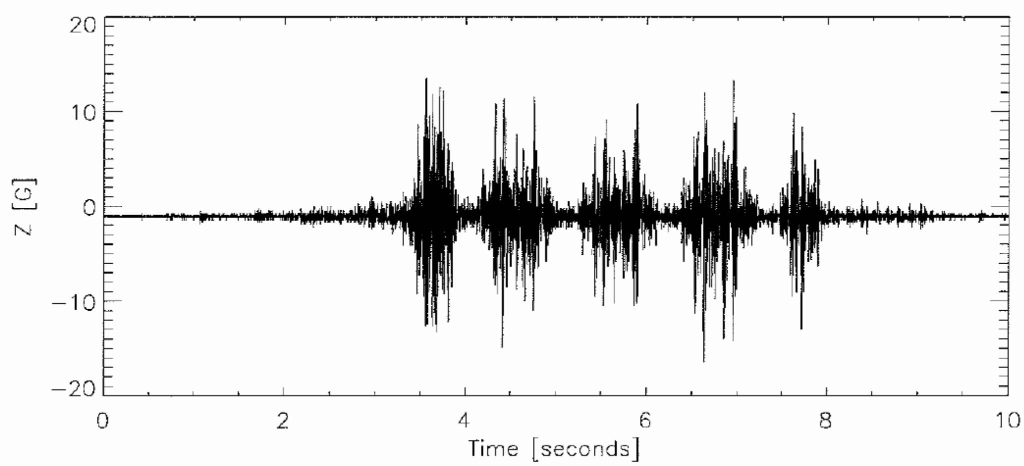

Figure 4 Sample 8: Mid-span, 4-car train

Conclusion

In concluding, the crux of this document is summarized by the following two points. First, most application environments do not see vibration induced accelerations close to those of Color Kinetics test specifications. Second, for environments prone to large or continuous vibrations, it is paramount that qualified individuals accurately assess localized characteristics of exact, real world conditions and design appropriate damping systems to assure the longevity of specified products.