

# Building Condition Assessment Metrics: Best Practices

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## ABSTRACT

This paper briefly describes the various building condition assessment metrics, including their strengths and weaknesses and how they support building infrastructure asset management. The approaches fall into two categories: monetary-derived and engineering-derived. Monetary approaches include backlog and the Facility Condition Index (FCI), both of which are economic or financial health metrics. The engineering-derived approach is the Building Condition Index (BCI) series, which is a performance health metric. Addressed in this paper is why both the FCI and BCI condition assessment metrics constitute a building asset management “best practice” when used together and computed from a distress-based inspection process.

## INTRODUCTION

Infrastructure asset management encompasses a wide variety of activities. These include asset inventory, inspection, condition assessment and prediction, short- and long- range maintenance and repair (M&R) work planning, and budgeting. This paper focuses on best practices in condition assessment, as applied to buildings.

Condition assessment consists of translating inspection data into one or more meaningful condition metrics, which are then used to support the infrastructure asset management decision-making process. Ideally, the metrics should be robust yet affordable to obtain. The small number of building condition assessment metrics that have evolved over the years fall into two basic categories: monetary-derived and engineering-derived. Each metric and approach is discussed below along with its strengths, weaknesses, and applicability to building infrastructure asset management.

## MONETARY-DERIVED BUILDING CONDITION METRICS

### Monetary Backlog

Perhaps the oldest, simplest, and most widely used condition metric is the monetary backlog of unfunded (deferred) work. Buildings age and endure usage; thus, some degradation is always occurring. This degradation leads to deficiencies in building components that negatively affect their performance. A deferred work backlog results if these deficiencies are not corrected through repair or replacement (capital renewal).

Traditionally, a building inspection is performed, in part, to identify component deficiencies and estimate the current cost to correct those deficiencies. The inspector may also assign a priority classification to the proposed work. Because of M&R budget limitations, only the highest priority work will be funded and the lower priority work will be deferred. The total estimate of all deferred work determines the facility backlog. However, experience with the backlog metric, especially for large building portfolios (military installations), has shown that factors other than degradation can affect the reported backlog.

During periods of lean M&R budgets, inspections may become less frequent and thus some deficiencies may remain undiscovered. Also, since deficiency identification is often based on an individual inspector's subjective judgment, inspectors may ignore reporting certain deficiencies that they feel will not be funded for correction. Additionally, reporting deficiency inspection results from past years may misrepresent the backlog, since the scope and cost of corrective action become dated and less accurate as a component further ages and degrades. To counter this, costs are sometimes inflated in an attempt to keep them current (DOD 2001).

Ideally, accurate condition assessment should be independent of expected M&R budget levels. In a standardized condition reporting process, the probability or sense of a deficiency correction getting funded should have no bearing on the identification of that deficiency. However, the authors can attest that during periods of increased M&R budgets (in an attempt to reduce the backlog), the reported backlog often increased (or decreased less than expected) because inspectors would begin to record deficiencies that had previously been ignored or address areas that had not been inspected.

The use of backlog amount as a condition metric can be misleading. Assuming that a zero backlog amount is unrealistic, how much backlog is acceptable? Since each building (or building portfolio) is somewhat unique because of its mission, use, and size and the nature of its deficiencies, each will have a different acceptable backlog level. Thus, comparing backlog amounts between buildings or portfolios is dubious. The Department of Defense cites various problems with the metric that are common to government agencies (DOD 2001) and itself stopped reporting backlog in FY01 because it is inaccurate, subjective, and unverifiable (GAO 2003).

### **Facility Condition Index (FCI)**

The FCI is the ratio of the total deficiency backlog cost to the building's current replacement value (CRV) (APPA 2003). The FCI is an improvement over the simple monetary backlog because it normalizes backlog based on the overall building economic value. Thus, the FCI is an indicator of the building's financial or economic health. The scale range is 0 – 1.00 (AME and Rush 1991) with 0 (best) reflecting no backlog and 1.00 (worst) representing a backlog equal to the building replacement value. (Note: Some agencies or organizations express FCI as a percentage. Also, some agencies compute an FCI at the building system level.) The following subjective condition ratings associated with FCI ranges have been suggested (AME and Rush 1991): Under 0.05 (Good); 0.05 - 0.10 (Fair); and over 0.10 (Poor). However, these ranges should not be taken as absolute or inflexible. Although outside the scope of this paper, there are other FCI-related monetary indexes. These include the Adaptive Index (AI), Facility Quality Index (FQI), and Capital Renewal Index (CRI) (APPA 2003).

There are shortcomings to the FCI metric. The numerator (deficiency backlog) in the ratio is subject to all of the same inspection problems addressed above. Also, there is no single universally accepted method for computing the CRV. While this poses little problem within a given agency (assuming all buildings have the CRV computed the same way) it may be problematic for comparing FCIs across agencies. Finally, as a monetary-derived metric, the FCI may not necessarily equate to building performance health.

### **ENGINEERING-DERIVED CONDITION METRICS**

An engineering-derived condition assessment approach, called the Building Condition Index (BCI) series, has been developed by the U.S. Army Engineering Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to measure building asset condition. This BCI series follows the same condition assessment methodology and meaning created for pavements, railroad track, and roofs as part of the Engineered Management System (EMS) research and development for PAVER, RAILER, ROOFER, and BUILDER (ERDC-CERL 2006). All utilize the same 0-100 scale, with 100 being defined as free from observable distress.

A primary BCI research objective was to overcome the problems associated with deficiency-based inspections. A structured inspection method was developed that requires inspectors to observe, identify, and record pre-defined, easily identifiable, distress types existing in the various subcomponents of an asset assembly (component-section – a component further defined primarily by material and type) present in a building (Uzarski 2004). A distress is a visual (or other observable) cue of a current or impending problem affecting the performance of a building component. During this standardized process, all observed distresses are recorded, along with an associated severity level and affected density measure for each. The inspector does not develop a corrective work scope and cost or prioritize the importance of problems identified, although obvious critical distresses are flagged for

quick resolution. This structured inspection approach is fast and repeatable and largely avoids the subjectivity associated with deficiency-type inspections.

The collected distress information is used to compute a component-section condition index (CSCI) metric. By definition, the CSCI reflects a component-section's current ability to perform properly as it degrades from use, exposure, and/or other mechanisms and is an indicator of M&R requirements for restoring or sustaining the component-section to an acceptable condition. Using rating scale development theory, expert panels of engineers, architects, and technicians were engaged in defining the distress types and severity levels, as well as the association of these distress types, severity levels, and densities with condition rating deduct values for subcomponents and component-sections. Each distress observed during an inspection results in these deduct values being subtracted from the perfect score of 100 to determine the CSCI (Uzarski and Burley 1997). Thus, a distress-based inspection by a trained technician results in a condition assessment metric (as measured by the CSCI) that reflects the rating from an independent panel of expert engineers and architects. The CSCIs are then used to compute overall aggregate CIs for components, systems, buildings, building groups, and entire portfolios. These higher level CIs are weighted averages (based on replacement cost) of the CSCIs (Uzarski and Burley 1997).

A shortcoming to the BCI method is that the building system inventory must be available in a computerized format prior to the inspection (or it must be collected as part of an initial inspection). Knowing what component-sections are present in a given building is needed to establish the relative weightings for the CI roll-ups. Consequently, missing or incomplete inventory will adversely affect the CI roll-up results. While there are asset management benefits to knowing the system inventory, it does take time and resources to collect this information. However, this cost is paid back through inspection efficiency and reduced inspection costs, as compared to deficiency-type inspections.

## **APPLICATION AND VALUE TO BUILDING ASSET MANAGEMENT**

Condition assessment metrics provide value only if they contribute to the building infrastructure asset management decision support process. The contributions of both the FCI and the BCI series are discussed below.

The simplicity of the FCI has made it a popular and widely used condition metric. If an inspection program is in place, the FCI is very easy to compute, and its very definition makes it easy to understand. The FCI allows for condition comparisons across buildings and building portfolios and monetary degradation rates can be computed. The FCI is used in different M&R funding models (Briselden and Cain 2001).

The inherent problems with the FCI numerator can be overcome. M&R planning costs can be correlated to CSCI with sufficient accuracy to support long-range work planning (Grussing, et. al. 2006). Coupling these cost models with the CSCI prediction models allows for building condition metrics and monetary M&R

backlog requirements to be projected in real time (and beyond) for an entire building portfolio, even though inspections were performed at different dates in the past. Since costs are correlated to CSCI, both FCI and BCI metrics can be computed from the same set of distress-based inspection data. Thus, the consistency and accuracy of the FCI is enhanced by employing a distress-type inspection method. This greater accuracy results in better facility comparisons, refined monetary degradation rates, enhanced condition reporting, and improved funding model outcomes.

The CSCI portion of the BCI series is used to track each component-section's unique life-cycle condition, determine degradation rates, predict future condition, and develop short- and long-range work plans and budgets (Grussing, et al. 2006). The CSCI can also be used to establish condition standards. A standard is defined as the minimum acceptable condition required for ensuring the performance, usefulness, and reliability of a given component-section. Standards can be established and tailored for different buildings, systems, and components and then applied to their subordinate component-sections. When the CSCI is below the standard, M&R is needed. When the CSCI is above the standard, M&R is not needed, except for critical distresses (discussed above). The BCI series is also a comparison measure and can be used for M&R prioritization and justification.

## CONCLUSIONS

An objective and repeatable inspection process is essential to an accurate and credible condition assessment measure. The monetary-derived measures of backlog and the FCI have several shortcomings due primarily to inconsistencies in the deficiency-based inspection process used to feed the metrics. However, the FCI gains accuracy and enhanced credibility when it is computed from a distress-based inspection method because the measure is computed through a more objective and repeatable work backlog identification process. This enhanced FCI is a best practice condition assessment metric.

The engineering-derived BCI series condition assessment metric measures how degradation affects component-section and building performance. It is a best practice measure for reporting condition due to its derivation process, consistency, and robustness.

Building asset management best practices should employ multiple condition metrics. Each category of condition metric—economic and performance-based—provides an important perspective to the facility manager's asset management decision-making process.

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