

# A BIM-based approach for improving building façade inspection in cities

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## Challenges in façade inspection

**Guideline:**  
Material based  
E.g., Crack in stones

**Practice: Component based**  
E.g., Coating corrosion at window lintel

**Conflict in guidelines vs. practice**  
Material-based vs. Component-based

**Manual and visual inspection:**  
Inconsistent inspection and wide range of omissions

**Inspectors group and visualize findings in different ways**

Parent component

```

graph TD
    PC[Parent component] --> C1[Comp1]
    PC --> C2[Component2]
    PC --> C3[Component3]
    C1 --> D1[Defect1]
    C1 --> D2[Defect2]
    C1 --> Dn[Defect n]
    
```

Parent defect

```

graph TD
    PD[Parent defect] --> D1[Defect1]
    PD --> D2[Defect2]
    PD --> D3[Defect3]
    D1 --> C1[Component1]
    D1 --> C2[Comp2]
    D1 --> Cn[Comp n]
    
```

## Expected Contributions

- Hierarchy of building façade components
- Taxonomy of defects
- Algorithm that reasons with BIMs to generate customized façade inspection checklists
- An algorithm that leverages information visualization taxonomy to group and visualize inspection data (per preference)

## Publications

- Shi, Z. and Ergan, S. (2021). An ontology towards BIM-based guidance of building façade maintenance. *Proceedings of the 38th ISARC, November 2-3, Dubai, UAE.*
- Shi, Z., Park, K., Ergan, S. (2020). Towards a comprehensive façade inspection process: An NLP-based analysis of historical façade inspection reports for knowledge discovery. *Proceedings of the 37th ISARC, October 27-28, Kitakyushu, Japan.*
- Shi, Z., Ergan, S. (2020). Towards Point Cloud and Model-Based Urban Façade Inspection: Challenges in the Urban Façade Inspection Process. In *Construction Research Congress 2020: Safety, Workforce, and Education* (pp. 385-394). Reston, VA: American Society of Civil Engineers.
- Shi, Z., Ergan, S. (2018). Leveraging point cloud data for detecting building façade deteriorations caused by neighboring construction. *Tamap Journal of Engineering*, 2018.0

## A model-based generation of comprehensive checklists and flexible visualization of inspection findings

Identify characteristics of façade inspection information requirements

Generate a customized checklist based on the BIM of a target building

Enable flexible data regrouping and visualization of inspection findings

Review of guidelines, glossaries, etc.

NLP based analysis of historical inspection reports

Shadowing inspectors

**Defining taxonomies**

E.g.: 6th floor window spandrel horizontal crack, classification safe, photo#.

At the interface of the rail posts to the concrete slab, the concrete has debonded, cracked, and spalled at several locations.

Review of digital component libraries

**Defining relationships**

**Semantically rich BIM**

**Taxonomy of defects**

**Defect – Component mappings**

**ChecklistGenerator**

```

graph TD
    subgraph Exterior_window [Exterior window]
        D1[Displacement]
        D2[Fracture]
        D3[Hole]
    end
    subgraph Lintel [Lintel]
        D4[Loose]
        D5[Corrosion]
        D6[Spall]
    end
    subgraph Sill [Sill]
        D7[Loose]
        D8[Broken]
        D9[Delamination]
    end
    subgraph Brick_masonry_wall [Brick masonry wall]
        D10[Efflorescence]
        D11[Missing mortar]
        D12[Water leakage]
    end
    subgraph Parapet [Parapet]
        D13[Loose brick]
        D14[Missing mortar]
        D15[Displacement]
    end
    
```

**Information visualization over BIM**

E.g., color coded symbols at detected locations for defects

Crack

Staining

Spall

Corrosion

Categories	Applicable visualization techniques
Blending	Color coding Pattern coding Animation
Embedding	Symbol/metaphor Text overlay/annotation Chart overlay
Multi-viewing	N/A

**Classification of visualization techniques**

Ref: Yang, X., & Ergan, S. (2014). Evaluation of visualization techniques for use by facility operators during monitoring tasks. *Automation in Construction*, 44, 103-118.