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IFC-based information interoperability process for freeform building

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Abstract. Communication is totally the most important factors in the building environment. IFC is construction industry standard integrated model. IFC had been developed for interoperability of different information modeling tools. It is compatible with the architectural geometric information modeling tools. It is compatible with the architectural geometric information as well as architectural properties Due to the increasing trend in the value of freeform building's landmark, BIM is essential about complex building. Open-BIM environment is important factor for communication between each other. Geometric information is not perfectly transfer each other tool in large scale freeform building project. Use of BIM about freeform building spends a lot of cost and time because of separately drawing only in specific tool. Aim of this study defines the information of complex geometric in the freeform building. It proposed to interoperability process by converting freeform geometry into IFC file. This study will improve interoperability of geometric and properties about freeform building. It will improve communication about each other task in the fields of construction industry.

Keywords: IFC, freeform building, Open-BIM, Interoperability

1 Introduction

Freeform building has been variously designed by the architects in construction industry. Recently freeform building is increasing by landmark values [1]. BIM is essential element about freeform building. Open-BIM environment is important factor for communication between each other because of information interoperability. Geometry information is not perfectly transferring each other tools in freeform building project. Use of BIM about freeform building spends a lot of cost and time on separately drawing only in specific tool. This study proposed to interoperability process by converting freeform geometry into IFC file.

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2 Related works

Information distort and loss have occurred about complex geometry from past to now in IFC based geometry information interoperability. VTT research project SPADEX marked the IFC 1.5.1 release as not suitable for use in the real life projects due to the lack of software specific IFC documentation [2]. Geometry exchanging error is reported in IFC 2.0 interoperability test about simple architectural model [3]. Pazlar conducts IFC 2x ADD1 interoperability test and concluded that data structure is to be improved for complex geometry as a result of test [4]. IFC is consistently improved and released in the buildingSMART International. However, complex shape information exchanging problems are occurring continuously.

The implementation of IFC interoperability about freeform shape is not trivial process. Freeform geometry information data entity is added in released IFC4. This study proposes IFC4-based interoperability process about freeform geometry.

3 Analysis of General IFC based freeform Interoperability Test

3.1 Overview of freeform building shape

Freeform is the opposite meaning that refers to the order of proportional symmetry, geometric order such as orthopedic homogeneous elements. Freeform shape generally has a type of freeform curved and intense diagonal and a tendency to deviate from the conventional three-dimensional [5]. Classification of freeform shape divides into three types (e.g., linear form, segmented form, free form). The three types are classified according to the panel constituting the form.

3.2 General IFC based freeform interoperability test

Architect generally uses NURBS based Rhino3d in design phase. Rhino3d don't support the IFC file format. In order to transfer BIM Authoring tools, after the test exports line-based file format (dwg, stl, sat) from Rhino3d, BIM Authoring tools import a line-based file format. BIM Authoring Tools export to IFC2x3 file. Finally IFC2x3 checked in Solibri Model Checker for validating information interoperability.

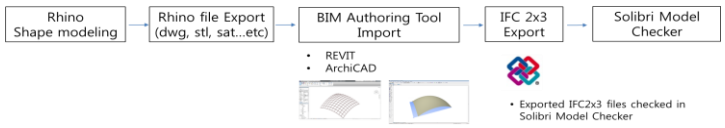

Fig. 1. General IFC- based freeform interoperability process.

Interoperability test conducts with four types of classified freeform shape building according to process. As a result of conducting interoperability test from freeform types, all of freeform shape can't covert IFC file in REVIT 2015. As all of freeform shapes convert IFC file in ArchiCAD18, it show that are transformed from line based file conversion. For this, it is necessary to directly convert the IFC file and support the IFC file about freeform shape.

4 Parametric freeform building interoperability process

4.1 Entity added in IFC 4

IFC4 improves data structure efficiency and adds to geometry entity. Entity that added in IFC4 follows Table.1.

Table 1. Entity added in IFC4 [6].

Geometry Resource	Geometry Model Resource
IfcBoundaryCurve	IfcAdvancedBrep
IfcBSplineCurveWithKnots	IfcAdvancedBrepwithVoids
IfcBSplineSurface	IfcCartesianPointList
IfcBSplineSurfaceWithKnots	IfcCartesianPointList3D
IfcCompositeCurveOnSurface	IfcExtrudedAreaSolidTapered
IfcCurveBoundedSurface	IfcFixedReferenceSweptAreaSolid
IfcCylindricalSurface	IfcRevolvedAreaSolidTapered
IfcPcurve	IfcSweptDiskSolidPolygonal
IfcRationalBSplineCurveWithKnots	IfcTessellatedFaceSet
IfcRationalBSplineSufaceWithKnots	IfcTessellatedItem
IfcReparametrisedCompositeCurveSegment	IfcTriangulatedFaceSet

As compared with IFC2x3, IFC4 added in freeform curve entity and freeform surface entity. Interoperability about geometry having curvature improves according to IFCBsplineSurfaceWithKnots and IfcBsplineCurveWithKnots. IFC2x3 happen information distortion and increases data capacity in order to express NURBS surface. However, IFC4 expect to improve NURBS surface interoperability. Also, IFC4 adds IfcCartesianPointList and IfcCartesianPointList3D entity in geometry model resource. Each face consist of a set of IfcLine that defines in Ifc CartesianPoint3D in IFC 2x3. However, face defined in IFC4 consists of IfcTriangulatedFaceSet and IfcCartesianPointList3d. For this, data capacity of IFC4 decreases in comparison with IFC2x3. It shows that IFC4 is possible to convert for freeform building shape and greatly improves data efficiency about freeform building shape. Furthermore, IFC4-based interoperability process will improve geometry information transfer accuracy.

4.2 IFC4-based parametric interoperability process about freeform building

This study proposes to IFC4-based parametric interoperability process using grasshopper and GeogymBIM. This process consists of architectural shape component and architectural property component. Freeform shapes are made from grasshopper and directly converted IFC file from GeogymBIM. IFC file is validated though importing REVIT2015.

5 Conclusion

This study improves accuracy of freeform geometry information in comparison with IFC2x3-based interoperability. It is simultaneously possible to make geometry information and architectural property information in CAD-tool. For this, proposed process will improve information loss because of directly converting to IFC file in comparison with indirect IFC based interoperability process. Finally, it will improve communication about each other task in the construction field.

Limitation of this study is that all of geometry can't convert to IFC4 using in development Add_in (GeogymBIM). As BIM authoring tools can't support IFC4, it is necessary to develop IFC mapping system for each BIM authoring tool.

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