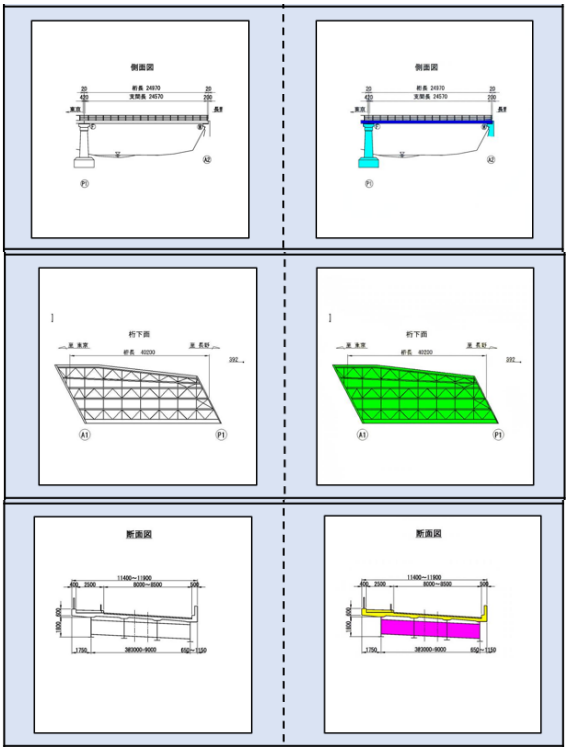
様式－３－２

研　究　成　果　の　要　約

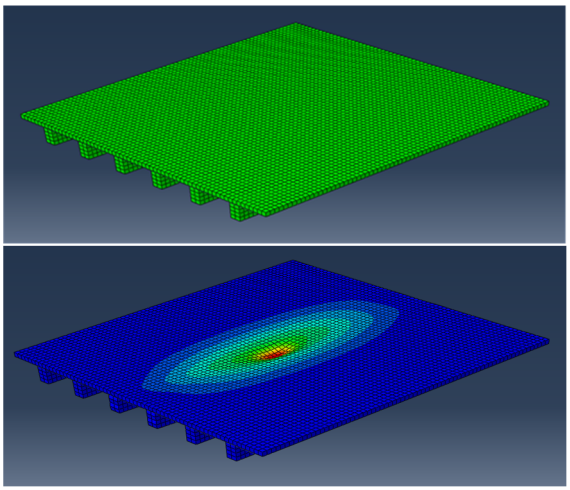
助成番号	助　成　研　究　名	研　究　者・所　属
第2020-1号	既存橋梁の2次元図面の意味解釈を通した 3次元CIMモデル自動生成手法の提案	全　邦釘 東京大学大学院工学系研究科

本研究では，まず橋梁構造物を対象とし，その2次元図面を読み込み，記載されている詳細な寸法や形状，表，単語の意味を理解した上で，3次元FEMモデルやCIMモデルを自動で構築するAIの研究開発を目的とする．特にここでは，本研究が最終的に目指すのは中小橋梁を含む全国の橋梁の3次元形状復元という点を踏まえ，もっともデータが揃っている，点検調書内に含まれる2次元図面を活用する．

まず2次元図面から形状を抽出するアルゴリズムを，pix2pixHDと呼ばれるDeep learningの一手法をベースとして開発した．以下に，側面図，平面図，断面図の抽出結果を示す．側面図の青色と水色はそれぞれ桁と橋台を，平面図の緑色は下面からの床版形状を，断面図の黄色とピンク色はそれぞれ床版と横桁を意味しているが，適切に抽出できている様子がわかる．



また，寸法をOCRで読み取り，それについてRDFで理解させる仕組みについても提示した．その結果から，３次元モデルを復元する方法論を提示し，試行を行った．例えばAbaqusで読み取り可能なFEMモデルを構築し，解析をした結果を以下の図に示す．なお，例えば材料定数などは図面からは読み取れないため，一般的な値を与えるシステムとなっている．



本研究は，都市のデジタルツイン構築のための基盤技術になると期待される．またこの成果は例えば以下の論文誌に投稿することを視野に入れている．

- 高impact factor英文誌（Computer-Aided Civil and Infrastructure Engineeringなど)
- 土木学会論文集
- 土木学会AI・データサイエンス論文集

時期は，来年度を想定しており，着実に成果をまとめている段階にある．

様式－３－３

DEVELOPMENT OF A METHOD FOR AUTOMATIC GENERATION OF 3D BRIDGE MODELS THROUGH SEMANTIC INTERPRETATION OF 2D DRAWINGS OF EXISTING BRIDGES

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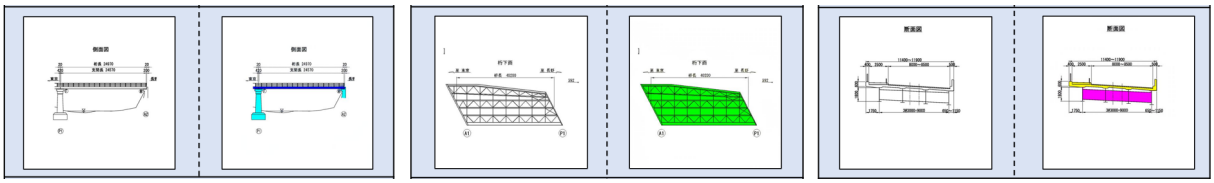
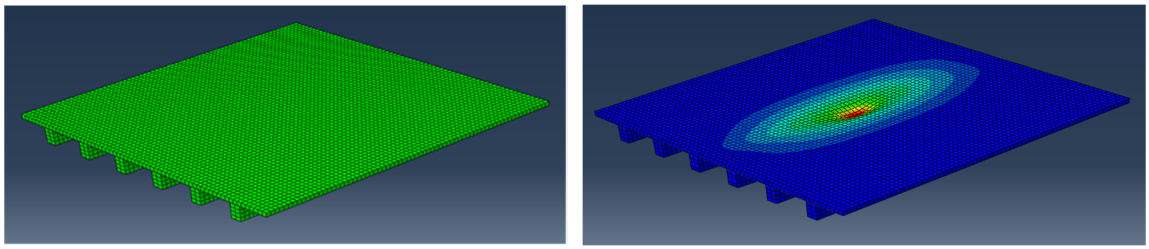
The objective of this research is to develop an AI that can read 2D drawings of bridge structures and automatically construct 3D FEM and CIM models based on an understanding of the detailed dimensions, shapes, tables, and meanings of words described in the drawings. In particular, since the ultimate goal of this research is to restore the 3D shapes of bridges all over Japan, including small and medium-sized bridges, the 2D drawings included in the inspection reports, for which the most data is available, will be used.

The objective of this research is to develop an AI that can read 2D drawings of bridge structures and automatically construct 3D FEM and CIM models based on an understanding of the detailed dimensions, shapes, tables, and meanings of words described in the drawings. In particular, since the ultimate goal of this research is to restore the 3D shapes of bridges all over Japan, including small and medium-sized bridges, the 2D drawings included in the inspection reports, for which the most data is available, will be used. First, we developed a modified algorithm for extracting shapes from 2D drawings based on a deep learning method called pix2pixHD. The following figures show the extraction results for the side view, plan view, and cross-sectional view. Blue and light blue in the side view indicate the girder and abutment, respectively; green in the plan view indicates the slab shape from the underside; and yellow and pink in the cross-sectional view indicate the slab and transverse girder, respectively.



We also presented a system to recognize dimensions by OCR and to understand them by RDF. Next, we presented a methodology to recover a 3D model from the recognition and understanding results, and conducted trials. For example, a FEM model that can be read by Abaqus was developed, and the results of the analysis are shown in the following figures. Note that the system gives general values for material constants, for example, since information not found in the drawings is not readable. This research is expected to be a fundamental technology for the development of the digital twin of the city.



KEYWORDS: *3-D digital twin, deep learning, pix2pixHD, drawings.*