論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Establishment of component design approaches to ensure anchor rods yielding in exposed steel column bases
著者(和文)	楊暁雨
Author(English)	Xiaoyu Yang
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第11832号, 授与年月日:2022年3月26日, 学位の種別:課程博士, 審査員:吉敷 祥一,元結 正次郎,河野 進,西村 康志郎,佐藤 大樹
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第11832号, Conferred date:2022/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	建築学 都市・環境学	系 コース	
学生氏名： Student's Name	楊　暁雨		

申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （　工 学　）
指導教員（主）： Academic Supervisor(main)	吉敷 祥一
指導教員（副）： Academic Supervisor(sub)	

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Exposed column bases are extensively used in low-to-medium rise steel structures. As a connection type between steel column and reinforced concrete foundation, they can transfer weight, seismic load, and wind loads from the superstructure to the sub-system, which makes exposed column bases in the most severe stress state. Moreover, the stress transfer mechanism in the column base is extremely complicated at various failure modes. Among all of the failure modes, one of them stated in the Japanese design recommendations is the yielding of anchor rods, with corresponding demands for the design of superstructures fully established. However, when considering the yielding of anchor rods, the anchorage of anchor rods must be kept. In other words, concrete breakout failure owing to the pull-out of anchor rods must be prevented. Also, with the tensile yielding of the anchor rods, in the compression side of exposed column bases, the bearing failure of the foundation concrete must be prevented. While in the current design recommendations in Japan, the statement of the calculation of concrete breakout failure strength and bearing stress was not clear. Furthermore, the experimental studies on them were limited in number. Thus, an experimental study was conducted with full-scaled exposed column base specimens. By analyzing the experiment results, the design approaches of concrete breakout failure strength and bearing stress are proposed.

In Chapter 2, experiment plan and results are introduced. There are ten full-scaled exposed column base specimens in total. Experiment parameters include the number of column longitudinal rebar, embedded length of anchor rods, type of anchor rods, strength of concrete foundation, etc. In the loading process, significant concrete breakout failure cracks were observed, which also caused the deterioration of strength. As a result, the concrete breakout failure strength calculated by the current design recommendation in Japan is higher than the experiment result about twice. As for the full-plastic moment, the calculation value using the current design recommendation fits the experiment result well. Furthermore, the influences of the parameters on the concrete breakout failure strength and bearing stress were clarified.

In Chapter 3, the design approach of concrete breakout failure is introduced. Based on the analysis of experiment results, the contribution of column rebar and the timing of concrete breakout failure are clarified. The current Column Base Recommendation in Japan overestimates the number of effective column rebar in the evaluation of concrete breakout failure strength. Not all of the column rebar in the concrete breakout failure area is contributed to the strength. Furthermore, in the case of exterior column-type column bases, the number of effective column rebar is related to the number of foundation beams. With the proposed consideration of effective column rebar number, in the calculation of maximum strength, using the current reduction factor 0.7 applying to the strength of column rebar fit experiment results well. Regarding the contribution of concrete, the strength at the instant when conical cracks occurred is experimentally obtained, after the crack occurred, the strength decreased and stabilized till the ultimate state. In the design of anchor rods considering the concrete breakout failure, to prevent the occurrence of conical cracks, it is proposed that only the contribution of concrete should be counted. After the crack occurred, the strength of effective column rebar can be added to calculate the ultimate strength. This proposal is proved available by the database containing previous experiment results related to concrete breakout failure.

In Chapter 4, the design approach of concrete bearing stress is introduced. The applicability and accuracy of current evaluation methods of bearing stress in the case of exposed column bases are discussed. Previous experiment data relate to exposed column base and anchor rods yielding are collected and analyzed. A method to normalize the experiment data is proposed. As for the evaluation result, the method stated in a recommendation of Architectural Institute of Japan can evaluate the strength most conservatively. About the method stated in a recommendation of American Concrete Institute and Kutani & Masuda's equation, they fit the LRFD design philosophy well. While considering the design philosophy in Japan, a relatively more conservative equation was proposed and it could reduce the number of overestimated specimens to approximately 19.3%.

In all, by conducting the experiments and analyzing the experiment results, the component design approaches are proposed to prevent concrete breakout failure and bearing failure in the exposed column bases. Following the design route of exposed column bases in Japan, considering the proposed calculation methods of concrete breakout failure and bearing stress, the yielding of anchor rod could be ensured.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

注意：論文要旨は、東工大リサーチリポジトリ(T2R2)にてインターネット公表されますので、公表可能な範囲の内容で作成してください。
Attention: Thesis Summary will be published on Tokyo Tech Research Repository Website (T2R2).