

論文 / 著書情報
Article / Book Information

題目(和文)	海洋環境に暴露した海水練りコンクリート中の鉄筋腐食に及ぼす低温の影響に関する研究
Title(English)	Influence of Cold Temperature on Steel Corrosion in Seawater Mixed Concrete Exposed to Marine Environment
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

専攻： 国際開発工学 専攻
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申請学位(専攻分野)： 博士 (工学)
Academic Degree Requested Doctor of
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要旨(英文 800 語程度)
Thesis Summary (approx.800 English Words)

In recent years, a long term project is planning in Arctic region to exploit the vast natural gas resource into the world energy market, for example Yamal peninsula, Russia. In the project, a large amount of concrete is utilized for construction of liquefied natural gas (LNG) plant facilities. The plant construction site located in Arctic region is an uninhabited remote area having less rainfall under extreme cold temperature condition and close to the sea shore. Under these site conditions, the procurement of freshwater is very difficult and expensive. On the other hand, LNG plant site is at the seaside and seawater is easy to access. Seawater can develop the strength of concrete for prevention of freezing of concrete and cold temperature condition can be expected low rebar corrosion. In case that feasibility of seawater usage in concrete mixing can be confirmed, tremendous construction cost reduction can be expected.

Therefore, the main purpose of the study is to investigate the behavior of steel corrosion in seawater mixed concrete exposed to marine environment in cold weather condition. In order to carry out the main purpose, the following objectives are set up as follows: (1) To study the material properties and durability of cast in-situ and anti-washout concrete mixed with seawater under cold temperature by investigating the influence of seawater mixing, cold temperature condition and admixtures on strength development, chloride ion diffusivity of concrete and rebar corrosion based on the results of short term experiment, (2) to clarify the material properties and durability of seawater mixed concrete after exposed to marine environment for 32 years by investigating the influence of seawater mixing, cover thickness and residual crack on the strength, corrosion crack occurrence of concrete and rebar corrosion based on the results of long term exposure test, (3) to propose the life time prediction method for seawater mixed concrete based on the results of objectives 1 and 2 above and predict the life time of seawater mixed concrete in cold temperature environment, and (4) to conduct the feasibility study on seawater mixed concrete in cold weather condition considering the factors such as strength, corrosion rate and life time.

From this study, the behavior of steel corrosion in seawater mixed concrete exposed to marine environment in cold weather condition was clearly understood. The results obtained in this study are summarized as follow;

In objective (1), the material properties and durability of cast in-situ and anti-washout seawater mixed mortar was investigated from the short term experiment by clarifying the influence of seawater mixing, cold curing temperature and admixtures on the strength development, chloride ion diffusivity and rebar corrosion. It was clarified that (a) the seawater mixed mortar can gain higher strength than freshwater mixed mortar in the cold temperature condition, (b) the seawater mixed with NaNO_2 or using BFS cement

can gain even higher strength, (c) chloride diffusivity can be reduced significantly by exposing the mortar specimens in cold temperature condition or mixing with the seawater due to low ion diffusion rate and formation of ice in cold temperature condition, and (d) the rebar corrosion rate can decrease when the exposure temperature decreases and mixing with admixture of NaNO_2 can control the rebar corrosion inside the seawater mixed mortar.

In objective (2), the material properties and durability of seawater mixed concrete was clarified based on the long term exposure test. It was clarified that (a) concrete strength after 32-year exposure is not affected by the type of mixing water, (b) regardless of presence of residual cracks, the corrosion of steel bars is uniform throughout the length and the effect of seawater is less after 32-year exposure, (c) there is no effect of residual crack and type of mixing water on oxygen permeability after 32-year exposure, and (d) visual inspection results agree with the corrosion measurement results.

In objective (3), the life time prediction method for seawater mixed concrete was successfully proposed based on the results of the short term and long term experiments. The life time of RC structure exposed to marine environment of Japan and Yamal was able to be estimated. The proposed method was validated by comparing with the actual deterioration condition of the specimens 32-year exposed to marine environment of Japan.

In objective (4), the feasibility study on seawater mixed concrete in cold weather condition was conducted by considering the strength, corrosion and life time. It was confirmed from the results that (a) seawater mixed concrete is more feasible in terms of strength, corrosion and life time in cold temperature than that in hot and moderate temperature conditions, (b) seawater mixed concrete shows lower risk than freshwater mixed concrete in cold temperature condition, and (c) seawater mixed concrete cases have lower risk level for strength and the same risk level for durability when it is utilized in cold weather condition of Yamal compared to Japan.

From the results and knowledge obtained in this study, it was able to understand the influence of cold temperature on material properties and durability of seawater mixed concrete exposed to marine environment. The recommendations and additional considerations required for practical use of seawater mixed concrete were also able to identify. The results of this study can be considered as a reference information for the future construction projects in the cold weather environment like Yamal which can contribute significantly to the society in term of concrete technology.

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 1 copy of 800 Words (English).

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