# Research on Efficient Physical Asset Management of Sewers

(Research period: FY2019 to FY2021)
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## 1. Introduction

The total length of sewers in Japan at the end of FY2020 was about 480,000 km. Out of this, the length of sewers older than the standard service life of 50 years was about 22,000 km (5% of the total length), and this number is expected to increase rapidly in the future to 76,000 km (16%) in 10 years and to 170,000 km (35%) in 20 years. The New Sewerage Vision Acceleration Strategy by the Sewerage and Wastewater Management Department of the MLIT in 2017 positioned the establishment of a physical asset management cycle as one of its key priorities. In order to contribute to formulation of technical policy and support for local governments in establishment of a physical asset management cycle for sewers, the Water Quality Control Department of the NILIM conducted the actual status survey on road cave-ins caused by sewers, update of the database on sewer pipe deterioration, and update of the soundness ratio prediction formula that contributes to the prediction of sewer pipe reconstruction demands, etc. In this paper, "sewer" is used as a generic term for sewer pipe (a.k.a., main pipe), manhole, lateral (pipe connecting sewer pipe and public inlet), public inlet, etc.

## 2. Grasping the actual status of road cave-ins caused by sewers

Since FY2006, the NILIM has conducted a survey on the occurrence of road cave-ins, etc. of local governments every year, in order to grasp the actual status of sewer deterioration, etc. on a macro level and to use survey results as a basis for research and policy making. In FY2020, there were about 2,750 cases of road cave-ins caused by sewers nationwide, and the number of cases has been decreasing in recent years (**Fig. 1**). As for the causative part of sewers, about 50% of all cases were caused by lateral (**Fig.2**). In terms of pipe type, concrete pipes account for about 60% of the road cave-ins caused by sewer pipe, while clay pipes account for about 70% of the road cave-ins caused by lateral. The downward trend in the number of road cave-in cases suggests that local governments have been encouraged to properly repair and reconstruct sewers through measures such as maintenance standards by FY2015 amendment to the Sewerage Act and the national subsidy program of physical asset management established in FY2016. However, it is necessary to continue to accumulate data, analyze the effects of measures, and consider measures that should be emphasized in the future.

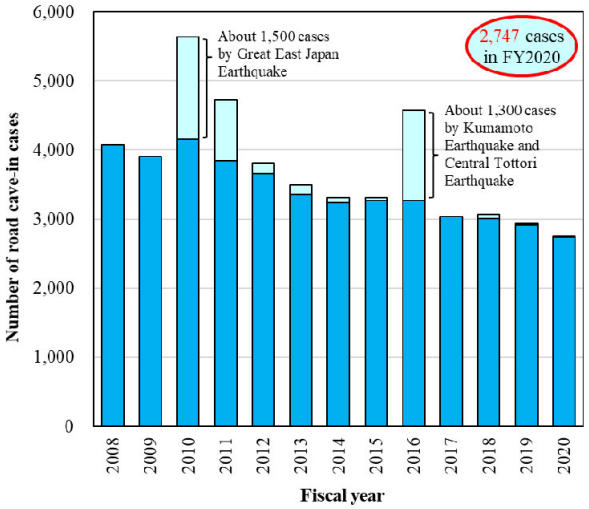
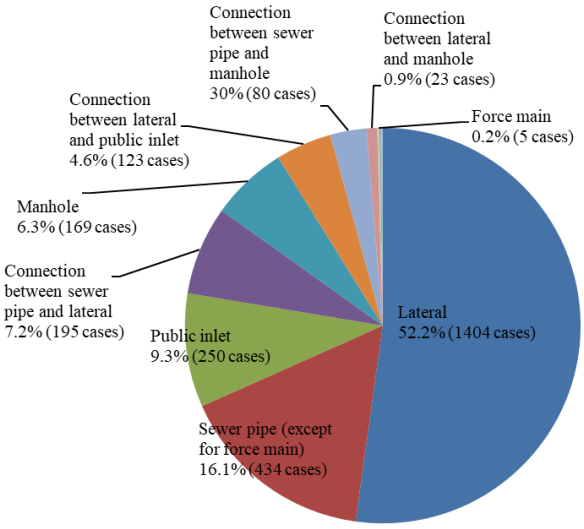



**Fig. 1: Number of road cave-in cases by year**




*Note: Exclusive of 57 cases where causative parts or exact cave-in locations are unknown*

**Fig. 2: Number and ratio of road cave-in cases by causative part (FY2020)**

## 3. Update of the Deterioration Database

The NILIM has compiled a database of some of the results of the survey on the inside of sewers collected from local governments (e.g., type of local government, elapsed year, pipe type, pipe diameter, installation conditions, deterioration and urgency assessment results) and has made it available to the public as "the Sewer Pipe Deterioration Database" ("the Deterioration Database"). The Deterioration Database Ver. 3, updated in June 2021, added data of about 60,000 spans to Ver. 2, released in 2017. As a result, data of about 310,000 spans of 60 local governments, has been registered. The registered data cover sewers with a total length of about 8,700 km, which is about 1.8% of 480,000 km of sewer pipes nationwide. The Deterioration Database has been used as supplementary data by local governments that have little accumulated inspection data in considering inspection priority areas and reconstruction demand forecasts.

## 4. Update of the Soundness Ratio Prediction Formula

In order to support local governments in formulating physical asset management plans, etc., the NILIM has made "the Sewer Pipe Soundness Ratio Prediction Formula" ("the Soundness Ratio Prediction Formula") available to the public since 2013. In June 2021, the Soundness Ratio Prediction Formula was updated. The Soundness Ratio Prediction Formula 2021 was calculated based on the inspection results of sewer pipes collected from local governments. The result data cover about 460,000 spans, of which about 310,000 are reinforced concrete (RC) pipes, 110,000 are clay pipes, and 20,000 are polyvinyl chloride (PVC) pipes. The Soundness Ratio Prediction Formula is a tool that can grasp the soundness ratio of sewers over time on a macro level, introduced in various guidelines, and is used as an indispensable tool for physical asset management practices by local governments.

The Soundness Ratio Prediction Formula is drawn as a graph with elapsed years as the explanatory variable on the horizontal axis and with the soundness ratio as the explained variable on the vertical axis. It represents the situation where the soundness ratio (percentage of sewers of high soundness) decreases as years pass. For example, from the graph of the Soundness Ratio Prediction Formula 2021 of RC pipes shown in **Fig. 3**, it is predicted that, for the overall 50 year old RC pipes, about 20% has no deterioration, while about 30% is in minor deterioration (Urgency III), about 40% is in moderate deterioration (Urgency II), and about 10% is in serious deterioration (Urgency I).

| Classification | Description | |
|---|---|---|
| Urgency I | Serious deterioration | Prompt measures are required. |
| Urgency II | Moderate deterioration | Simple measures can postpone necessary measures less than five years. |
| Urgency III | Minor deterioration | Simple measures can postpone necessary measures five years or more. |
| No deterioration | Sound | No special measures are required. |

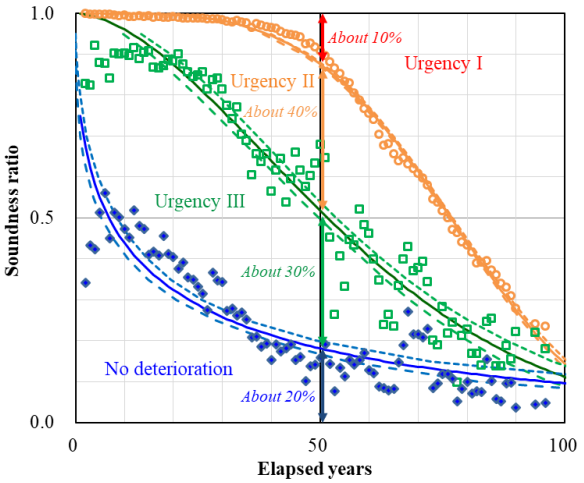



**Fig 3: Graph of Soundness Ratio Prediction Formula 2021 (Example of RC pipe)**

The Soundness Ratio Prediction Formula can predict medium- to long-term reconstruction demand on a macro level based on information on pipe types and elapsed years. On the other hand, even if the elapsed years are the same, there are variations in the deterioration status, which indicates it is important to grasp the deterioration status of individual sewers through inspections in a systematic manner.

## 5. Conclusion

The NILIM will continue to contribute to the establishment of a physical asset management cycle for sewers through grasping the actual status of road cave-ins caused by sewers, updating the Deterioration Database, and improving the Soundness Ratio Prediction Formula. In particular, the NILIM plan to analyze the deterioration trend of sewers and explore the Soundness Ratio Prediction Formula of PVC pipes, which are widely installed in small and medium-sized local governments.

☞ **See the following for details.**

1) Length of sewer pipes installed
https://www.mlit.go.jp/mizukokudo/sewerage/crd_sewerage_tk_000135.html
2) Sewer Pipe Deterioration Database 2021
http://www.nilim.go.jp/lab/ebg/rekka-db.html
3) Sewer Pipe Soundness Ratio Prediction Formula 2021
http://www.nilim.go.jp/lab/ebg/deterioration_rate_prediction_formula_2021.pdf