Survey and research concerning long distance inclined pipes in Eba district (pt. 2) (Hiroshima City)

Year of Research	2012・2013	Implementation of anti-inundation measures

(Purpose)

The city of Hiroshima is currently installing a supplemental trunk sewer ("supplemental trunk A") which uses inclined pipes in multiple locations as the method for inflow connection. However, when waste gases concentrate in an inclined pipe they bring the risk of reversed flow and ejection of air and water, so when this method is used it is necessary to take this phenomenon into account and install dedicated facilities to handle such waste gases. With this in mind, based on the results of verification of the hydraulic inflow function in a previously verified single inclined pipe and in order to confirm whether waste gas handling facilities are necessary in supplemental trunk A as a whole, we performed a hydraulic model experiment that recreated a section of a supplemental trunk sewer so we could make proposals for the countermeasures required and confirm the effects of such countermeasures with risk avoidance as the goal.

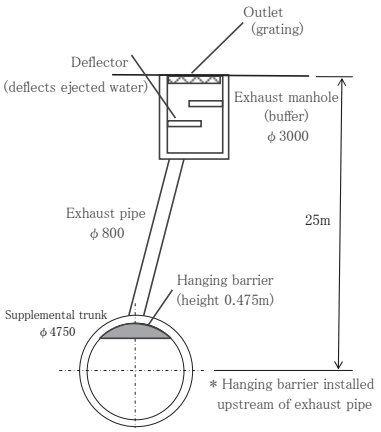

Figure 1: Overview of hanging barriers

(Results)

(1) Verification of preliminary version and consideration of causes

After verifying the flow status at each level of implementation in the preliminary version, it was discovered that in facilities that are in service, there are no ejections of air or bodies of water of note, but in future plans, areas where the flow volume reaches its peak will experience a buildup of residual air inside the main pipe when it reaches capacity, making the inclined pipe prone to ejecting water and air.

It was revealed that the preliminary version faces the following three issues.

a) Buildup of residual air that made a reverse flow in a bore is compressed and ejected by the dynamic water pressure

b) Buildup of air remaining inside the inclined pipe is ejected by the dynamic water pressure

c) Buildup of residual air is compressed and ejected as a result of a reverse flow in the bore from the downstream pumping station

(2) Investigation into countermeasure proposals and verification of effects

Based on the issues above, we verified the effects of the countermeasures investigated.

1) Countermeasures for inclined pipe furthest downstream

The pipe located furthest downstream can be considered a hazardous location in which the flow of air that has built up in the section upto its supplementary downstream pumping station reverses direction due to bore flow or other factors and causes a concentration of waste gases. As such, we installed a hanging barrier as shown in **Figure 1** to augment moving air and expel it through an exhaust

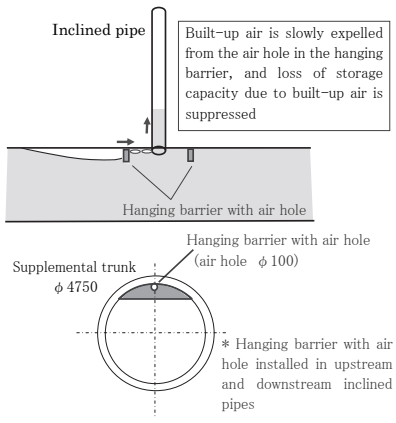

Figure 2: Overview of hanging barriers with air holes

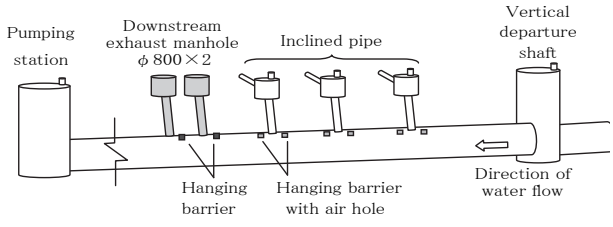

Figure 3: Layout of countermeasure plan

manhole. With regard to the scale of the facility, the ejection of water mass and air can be eliminated through the installation of a hanging barrier and exhaust manhole in two locations immediately downstream of the inclined pipe that exists furthest downstream.

2) Countermeasures for consecutive inclined pipes upstream

Because inclined pipes carry an amount of air consumate to the inflow volume, consecutive upstream inclined pipes compress this carried air, leading to the potential for ejection of water mass and air. As such, as shown in **Figure 2** and **Figure 3**, the ejection of water mass and air can be eliminated through the installation of a hanging barrier with an airhole (φ100mm) in the upstream and downstram inclined pipes.

(Summary)

Although inclined pipes have a high implementability, they bring the risk of great damage through launched manhole covers and other problems. However, we confirmed that by using this research as reference when taking countermeasures, it is possible to implement safe facility operation.

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Key words	Drop structure, Inclined pipe, Air pipe