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EFFECTS OF MEASURES TO DECREASE THE REVERBERATION TIME IN SHIPBUILDING HALLS.

J.H. van den Berg

Dutch Labour Inspectorate,
Postbox 30,016, 9700 RM Groningen,
Holland.

In the Netherlands ships are nowadays often built in shipbuilding halls constructed from corrugated steel-plates. Unless special measures are taken, these alls have a long reverberation time (called R.T.) This has a number of negative effects on the people who have to work in these halls. It is possible to decrease the R.T. to an acceptable level by appropriate measures. We calculated the average R.T. of the frequencies ½K, 1K, 2K, 4K. Since these frequencies are predominantly present in the typical noise in these halls.

The shipbuilding halls.

Hall.nr.	Volume m3	Surface m^2	R.T. in sec. non-absorbing	absorbing	decrease factor R.T.
1	50.000	2.100	6,4	2,3	2,8
2	16.500	1.100	4,2	2,3	1,8
3	140.000	5.000	5,9		
3	42.000	1.600		2,8	2,1

Hall 3 has an absorbing and a non-absorbing section in open connection with each other.

The measures.

Hall 1 was an existing hall. To decrease the R.T., rockwool baffles were installed at the ceiling of this hall. Two baffles per square meter were chosen, dimensions 1200x600 mm, thickness 80 mm into a dust-proof foil (picture).
The employes of the ship-yard carried out this job themselves. It was done outside the working-hours and a platform built on an overhead-crane was used. The costs were ƒ 50,- per m^2, average absorption was 1,4 m^2 Sabine per m^2 surface, pricelevel 1980.

for hall 2 and 3 was chosen for a different type of construction. Hall 2 was also an existing situation. The absorbing part of hall 3 was recently built. In these halls a heat-insulati . and sound absorbing corrugated steel-plate was put, in order to improve the heat insulation of the walls at the same time. It consisted of a perforated steel-plate; 40% perforation, a dust proof foil and 55 mm of glaswool insulation (picture).
In hall 2 this was attached to 50% surface of the walls, in hall 3, absorbing part this also was fixed on 50% surface of the walls and to the whole ceiling. The costs were ƒ 100,- per m^2, average absorption 1 m^2 Sabine per m^2 surface, price-level 1982.

The sound measurements.

We did frequency analyses from the L-eq measurements of the noise in the halls. It was evident that in an absorbing hall the high frequencies - like 1K, 2K and 4K - appeared considerably less than in a non-absorbing one. This is in connection with aspects of well-being. (diagram).
We also studied the decrease of the sound level with increasing distance. In hall 3-with sound-absorbing corrugated steel-plating- the curve of the absorbing hall is a few dB(A) below the curve of the non-absorbing hall. In hall 1 - with the baffle ceiling - the curve drops strongly. In hall 2 this effect was hardly measurable (diagram).
We also did measurements with dosesmeters. We measured a decrease of the L-eq. sound-load of about 3 or 4 dB(A) in hall 1. In hall 3 this was 2 dB(A). In hall 2 a decrease was hardly measurable.

Social aspects.

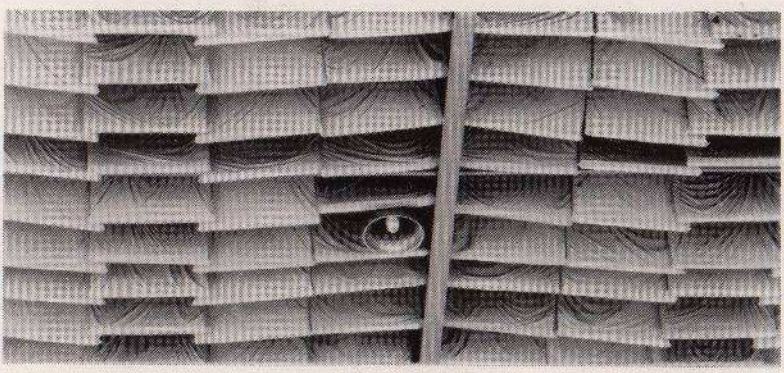
The reasons for managements to pay attention tot the improvement of working conditions were: complaints of the employes; communication problems on the workspot; workers mentioned the noise as one of the reasons when leaving the company; several workers had problems of medical nature with the hearing.
The reason for choosing the inside perforated corrugated steel-plating was the combining of the improvement of the heat-insulation of the walls, the lowering of the R.T. and aesthetical aspects.

The opinion of the employes was asked by means of a questionnaire.

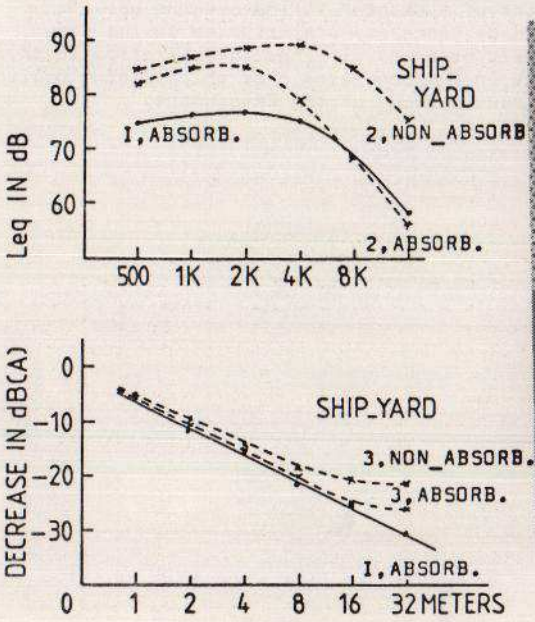
	Hall 1	Hall 2
No improvement noticeable	17 %	-
Hardly any improvement noticeable	21 %	60 %
Improvement noticeable	48 %	40 %
considerable improvement	7 %	-
significant improvement	7 %	-
less annoyance	83 %	53 %
better conversation	38 %	17 %

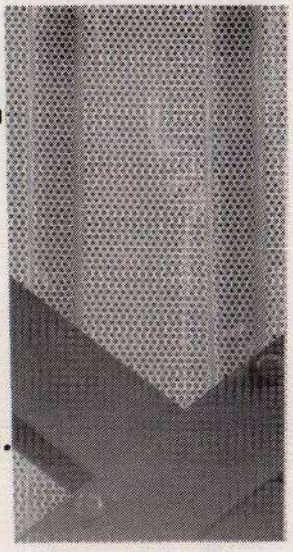
The measures taken give a positive result. The baffle ceiling has the best effects. A typical result is the decrease of the reverberation time of one third (average of the frequencies ½K, 1K, 2K, 4K). In spite of the high costs the management as well as the employes were satisfied with the measures taken.

The improvement of hall 1 and 2 were subsidized by the Dutch Government under supervision of the Dutch Labour Inspectorate all within the framework of a program to improve the working conditions. The ship-yards concerned are situated in the same area and knew each others problems with the reverberation in the halls. In a later stage in the same area more shipbuilding halls have been improved without subsidy of the Government.



BAFFLE CEILING





PERFORATED WALL