

## RESEARCHES REGARDING THE INFLUENCE OF VIBRATIONS ON THE OPERATOR IN THE GRAIN HARVESTERS

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### ABSTRACT:

The paper proposes an analysis of vibrations within many Romanian and foreign harvesters provided with tangential threshing unit, watching the influence which these ones have on the human operator's health. The determination of vibrations has been performed on the basis of accelerations measured at various frequencies, on the three directions: x, y and z (by means of the accelerometers mounted on the main working parts of the harvester), tracing the nomographs representing the limits up to which, these are not dangerous for the operator's health.

### KEYWORDS:

vibrations, harvester, accelerations, nomogram, frequency.

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## 1. INTRODUCTION

Vibrations are dynamic phenomena, which appear in elastic or quasi-elastic media after a local excitation and which are manifested by propagating the excitation within the medium under the form of some elastic oscillations. This, depending on the dynamics of the phenomenon there are met vibrations with low variation frequencies characteristic to the mechanical structures the construction structures and the earthquake waves, as well as vibrations with high variation frequencies.

The vibration measuring was performed on the following cereal harvesting machines with a tangential threshing unit: SEMA 140 M, NEW HOLLAND TC 56, TOPLINER 4075, NEW HOLLAND TX 66, LAVERDA L 6261, BIZON RECORD Z 058, in two conditions: at stationary and during work, by using transducers for each of the following harvester working parts: thresher, header, chassis and the operator's chair. On the basis of the values of longitudinal, cross and vertical accelerations measured to various frequencies in the two operating conditions of the harvester (at stationary and during work) it is established the effect of the vibrations on each of these parts and, finally, cumulated, the vibrations sent to the operator's chair, the nomograms being to be traced and being to be established the range with the limits up to which they are not dangerous for the operators health.

## 2. TESTS RESULTS

The results of the determinations on the vibrations sent to the chair of the harvester SEMA 140M are shown in table 1, fig. 1 and 2. On the basis of the values of  $a_x$ ,  $a_y$ ,  $a_z$ , accelerations measured at various frequencies and within the three possible conditions of the harvester operation (at stationary turing transport and work, some graphical representations have been performed. At stationary the accelerations, which have appeared were very low and from the nomograms with the admissible limits given by ISO 2631-78 it results that the operator can work without any danger for over 24 hours.

During the effective work (the coupled thresher) the biggest accelerations were registered on a longitudinal direction, respectively  $0,18 \text{ m/sq.s}$  at 2.5 Hz. It results that the operator could work ceaselessly, without any danger, for maximum 16 hours. During transport the vertical accelerations were the highest, reaching  $1.05 \text{ m/sq.s}$  at the frequency of 3.15 Hz, so the danger for the operator occurs only if the harvester runs ceaselessly for over 1.5 hours.

Table 1 - Accelerations measured on the three directions for the harvester SEMA 140M

f [Hz]		1	1,25	1,6	2	2,5	3,15	4	5	6,3	8	10	12,5	16	20	25	31,5	40	50	63	80	
C 140 M	Station	L	0	0	0	0	0	0	0	0	0	0	0	0,02	0,005	0,008	0,02	0,01	0,04	0,03	0,02	0,21
		C	0,005	0,007	0,003	0,004	0,002	0,002	0,002	0,002	0,001	0,005	0,004	0,01	0,01	0,02	0,13	0,05	0,03	0,04	0,02	0,16
		V	0	0	0	0	0	0	0	0	0	0	0	0,02	0	0,01	0,07	0,02	0,05	0,05	0,04	0,42
	Work	L	0,04	0,08	0,08	0,14	0,18	0,29	0,16	0,07	0,05	0,05	0,09	0,08	0,10	0,15	0,10	0,15	0,35	0,21	0,13	0,15
		C	0,06	0,14	0,12	0,14	0,10	0,08	0,05	0,05	0,05	0,04	0,04	0,06	0,07	0,10	0,08	0,14	0,32	0,31	0,15	0,10
		V	0,08	0,19	0,19	0,33	0,60	1,05	0,54	0,21	0,16	0,20	0,21	0,19	0,22	0,27	0,13	0,25	0,47	0,22	0,23	0,24
	Transp.	L	0,08	0,15	0,10	0,07	0,05	0,04	0,03	0,01	0,01	0,02	0,16	0,05	0,06	0,08	0,06	0,18	0,31	0,93	0,49	0,41
		C	0,08	0,14	0,10	0,06	0,04	0,03	0,04	0,05	0,09	0,06	0,03	0,05	0,07	0,08	0,16	0,55	0,39	1,11	0,48	0,68
		V	0,04	0,09	0,08	0,10	0,11	0,08	0,04	0,05	0,05	0,10	0,49	0,07	0,06	0,13	0,16	0,55	0,39	1,11	0,48	0,68

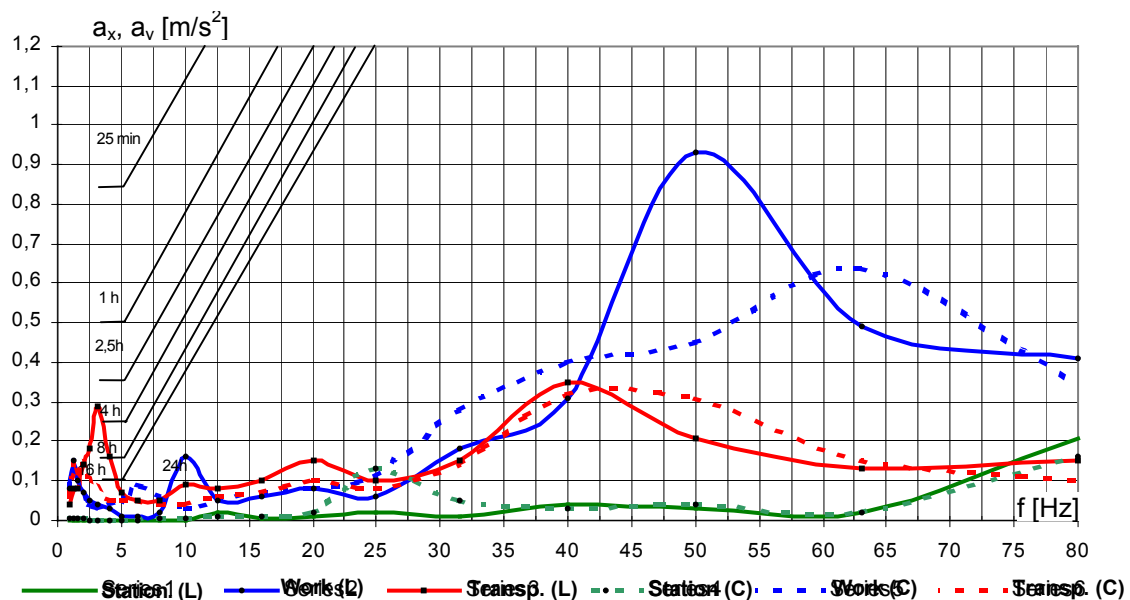


Figure 1 - Longitudinal and cross accelerations at stationary, during work and transport (SEMA 140M)

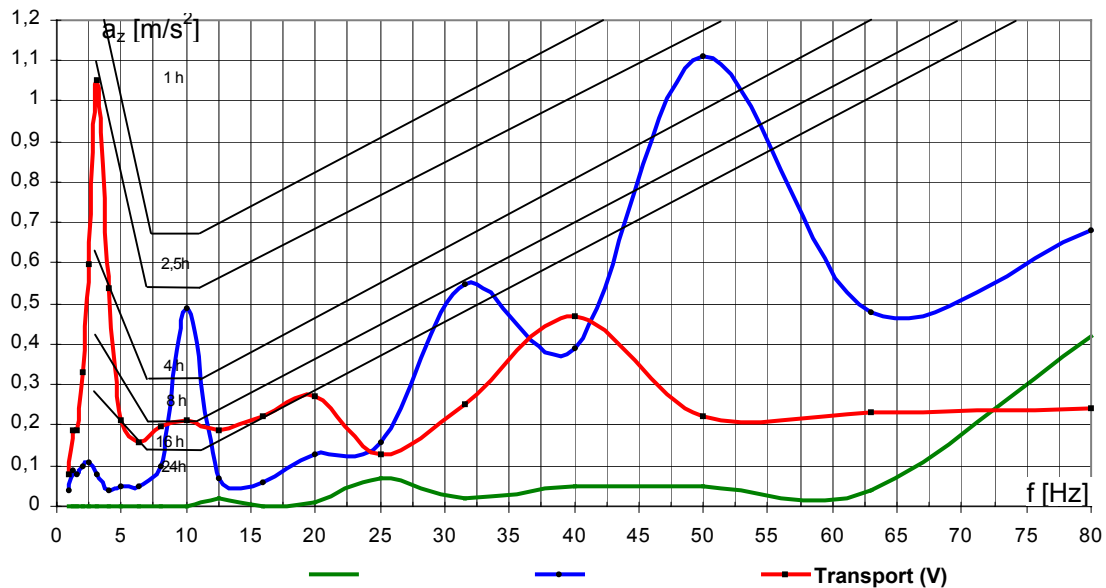


Figure 2 - Vertical accelerations at stationary, during work and transport (SEMA 140M)

The results of the determinations on the vibrations sent to the chair of the harvester NEW HOLLAND TC 56 are shown in table 2, fig. 3 and 4. Both at stationary and during the effective work, the accelerations were low, resulting in the operator's work without any danger for over 20 hours. During transport the vertical accelerations were the highest, reaching 0.18 m/sq.s at 8 Hz frequency, so the danger for the operator occurs only if the harvester runs ceaselessly for over 16 hours.

Table 2 - Accelerations measured on the three directions for the harvester NEW HOLLAND TC 56

f [Hz]		1	1,25	1,6	2	2,5	3,15	4	5	6,3	8	10	12,5	16	20	25	31,5	40	50	63	80		
NEW HOLLAND TC 56	Station.	L	0,005	0,007	0,004	0,007	0,006	0,007	0,014	0,019	0,056	0,033	0,012	0,042	0,05	0,13	0,14	0,10	0,43	0,21	0,13	0,18	
		T	0,006	0,009	0,008	0,014	0,007	0,007	0,019	0,019	0,006	0,004	0,003	0,002	0,002	0,002	0,001	0	0	0	0	0	0
		V	0,023	0,050	0,041	0,053	0,062	0,068	0,066	0,044	0,029	0,016	0,01	0,01	0,01	0,007	0,008	0,055	0,06	0,003	0	0	0
	Work	L	0,043	0,10	0,07	0,042	0,036	0,032	0,025	0,025	0,055	0,11	0,02	0,031	0,035	0,059	0,13	0,095	0,10	0,18	0,35	0,20	
		T	0,023	0,07	0,056	0,042	0,023	0,016	0,041	0,10	0,018	0,11	0,007	0,006	0,007	0,005	0	0	0	0	0	0	0
		V	0,021	0,046	0,032	0,041	0,05	0,07	0,06	0,05	0,012	0,01	0,005	0,003	0,005	0,005	0,001	0	0	0	0	0	0
	Transp.	L	0,05	0,10	0,078	0,086	0,077	0,097	0,079	0,037	0,025	0,011	0,012	0,025	0,021	0,07	0,015	0,08	0,07	0,062	0,085	0,032	
		T	0,058	0,13	0,12	0,10	0,06	0,039	0,021	0,02	0,012	0,01	0,01	0,007	0,007	0,004	0	0	0	0	0	0	0
		V	0,026	0,069	0,059	0,075	0,12	0,018	0,14	0,15	0,16	0,18	0,14	0,01	0,009	0,007	0,003	0	0	0	0	0	0

The results of the determinations on the vibrations sent to the chair of the harvester DEUTZ-FAHR TopLiner 4075 are shown in table 3, fig., 5 and 6. At stationary the operator can work without any danger for over 24 hours and during effective work - for maximum 20 hours (0.13 m/sq. s at 1.25 Hz). During transport the maximum vertical accelerations were 0.64 m/sq.s at 2.5 Hz and the cross ones 0.39 m/sq.s at 1.25 Hz, resulting in a danger for the operator if the harvester runs ceaselessly for over 3 hours.

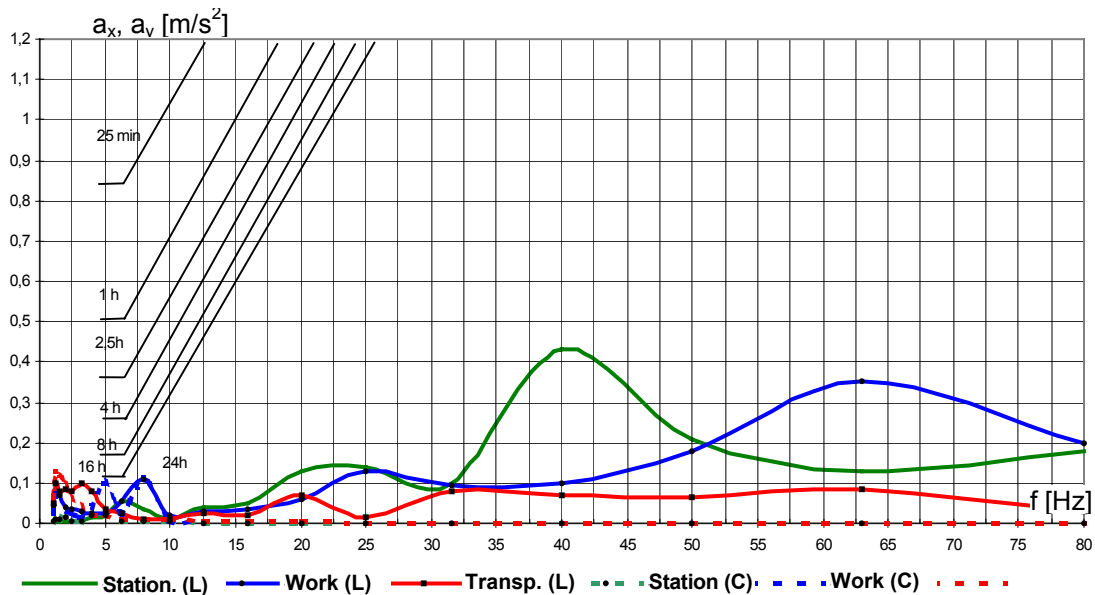


Figure 3 - Longitudinal and cross accelerations at stationary during work and transport (NH TC 56)

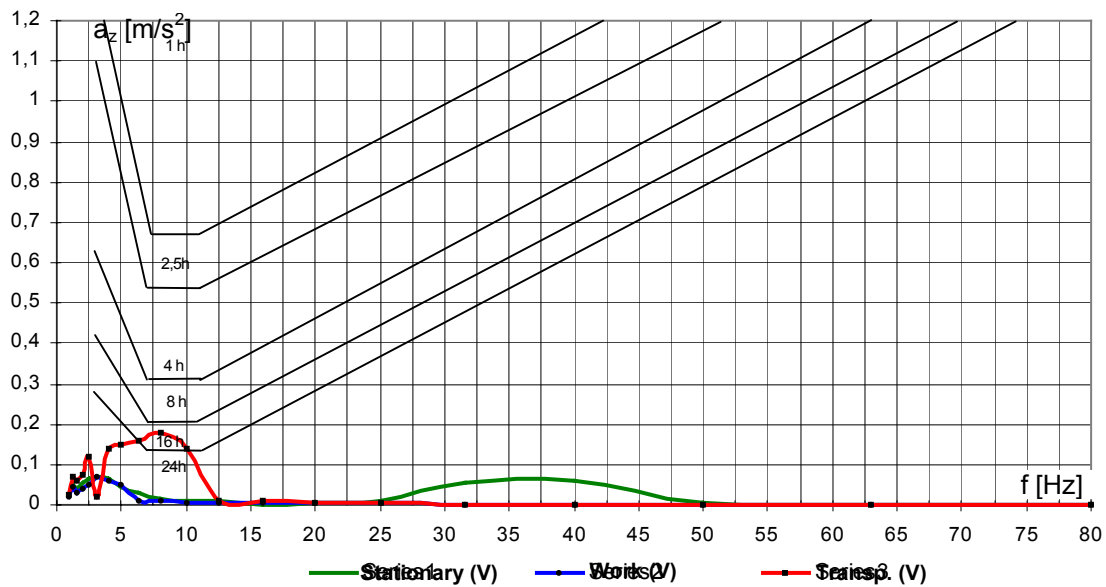


Figure 4 - Vertical accelerations at stationary, during work and transport (NH TC 56)

Table 3 - Accelerations measured on the three directions for the harvester DEUTZ - FAHR Top Liner 4075

f [Hz]		1	1,25	1,6	2	2,5	3,15	4	5	6,3	8	10	12,5	16	20	25	31,5	40	50	63	80	
DEUTZ-FAHR Topliner 4075	Station.	L	0	0,004	0,002	0,003	0,004	0,005	0,007	0,007	0,008	0,008	0,008	0,008	0,05	0,03	0,14	0,06	0,03	0,05	0,02	0,04
		T	0	0,002	0,002	0,002	0,002	0,003	0,004	0,004	0,004	0,004	0,003	0,004	0,06	0,03	0,05	0,02	0,03	0,15	0,02	0,1
		V	0	0	0	0,002	0,003	0,004	0,004	0,004	0,005	0,004	0,004	0,005	0,04	0,02	0,13	0,07	0,03	0,11	0,02	0,06
	Work	L	0,08	0,12	0,06	0,066	0,066	0,05	0,10	0,27	0,10	0,14	0,11	0,11	0,19	0,37	0,31	0,22	0,18	0,12	0,12	0,07
		T	0,08	0,13	0,05	0,04	0,04	0,09	0,08	0,11	0,19	0,20	0,08	0,14	0,17	0,19	0,13	0,08	0,24	0,14	0,20	0,21
		V	0,03	0,07	0,07	0,11	0,11	0,07	0,06	0,10	0,08	0,09	0,11	0,15	0,25	0,28	0,17	0,19	0,16	0,07	0,14	0,14
	Transp.	L	0,05	0,15	0,15	0,23	0,26	0,17	0,10	0,07	0,08	0,11	0,10	0,24	0,75	0,41	0,32	0,26	0,13	0,10	0,11	0,10
		T	0,26	0,39	0,17	0,13	0,12	0,14	0,10	0,11	0,16	0,25	0,14	0,39	0,58	0,18	0,11	0,10	0,18	0,15	0,23	0,28
		V	0,13	0,40	0,37	0,52	0,64	0,25	0,17	0,11	0,21	0,22	0,20	0,51	0,66	0,31	0,26	0,20	0,20	0,15	0,16	0,18

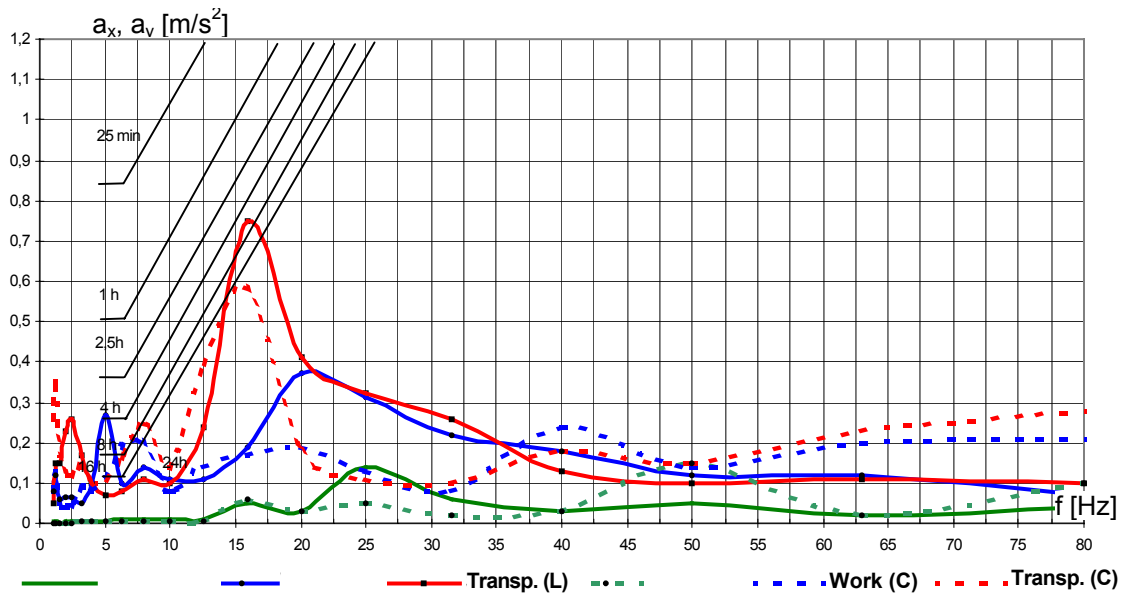


Figure 5 - Longitudinal and cross accelerations at stationary, during work and transport (DF Top Liner 4075)

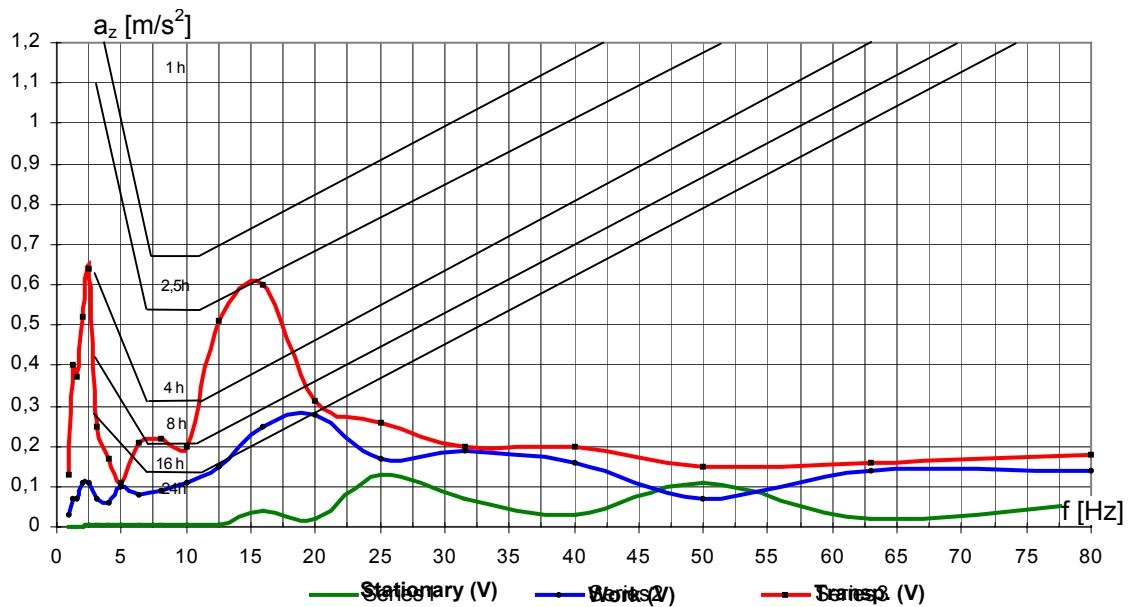


Figure 6 - Vertical accelerations at stationary, during work and transport (DF Top Liner 4075)

Table 4 - Accelerations measured on the three directions for the harvester LAVERDA L 626 I

f [Hz]		1	1,25	1,6	2	2,5	3,15	4	5	6,3	8	10	12,5	16	20	25	31,5	40	50	63	80	
LAVERDA L 626 I	Station	L	0	0,005	0,005	0	0	0	0	0	0	0	0,01	0,01	0,016	0,05	0,05	0,075	0,039	0,03	0,04	0,14
		T	0,003	0,006	0,005	0,006	0,005	0,005	0,005	0,004	0,005	0,017	0,027	0,056	0,049	0,12	0,065	0,082	0,021	0,021	0,021	0,17
		V	0,004	0,007	0,005	0,005	0,004	0,003	0,003	0,002	0,003	0,003	0,015	0,01	0,01	0,005	0,009	0,07	0,08	0,01	0,02	0,04
	Work	L	0,06	0,09	0,04	0,03	0,02	0,02	0,02	0,13	0,11	0,05	0,07	0,05	0,04	0,09	0,16	0,18	0,20	0,08	0,13	0,06
		T	0,04	0,09	0,08	0,13	0,10	0,07	0,04	0,13	0,10	0,07	0,21	0,13	0,34	0,21	0,35	0,20	0,14	0,07	0,14	0,07
		V	0,11	0,17	0,08	0,05	0,06	0,10	0,05	0,06	0,012	0,08	0,12	0,05	0,07	0,10	0,29	0,28	0,05	0,03	0,11	0,02
	Transp	L	0,06	0,11	0,11	0,18	0,21	0,10	0,07	0,09	0,09	0,07	0,07	0,08	0,13	1,34	0,56	0,29	0,24	0,10	0,15	0,04
		T	0,17	0,40	0,44	0,74	0,63	0,31	0,20	0,16	0,19	0,13	0,17	0,13	0,17	0,98	0,78	0,19	0,17	0,10	0,11	0,06
		V	0,10	0,18	0,11	0,08	0,08	0,11	0,10	0,10	0,12	0,16	0,13	0,08	0,12	1,44	0,98	0,23	0,08	0,03	0,12	0

The results of the determinations on the vibrations sent to the chair of the harvester LAVERDA L 626l are shown in table 4 figures 7 and 8. At stationary the operator can work without any danger for over 24 hours and during effective work for maximum 18 hours (0.13 m/sq.at 2.0 Hz). During transport the maximum vertical accelerations were 1.44 m/sq.s at 20 Hz and the cross ones - 0.74 m/sq.s at 2.0 Hz resulting in a danger for the operator if the harvester runs ceaselessly for over 1.5 hours.

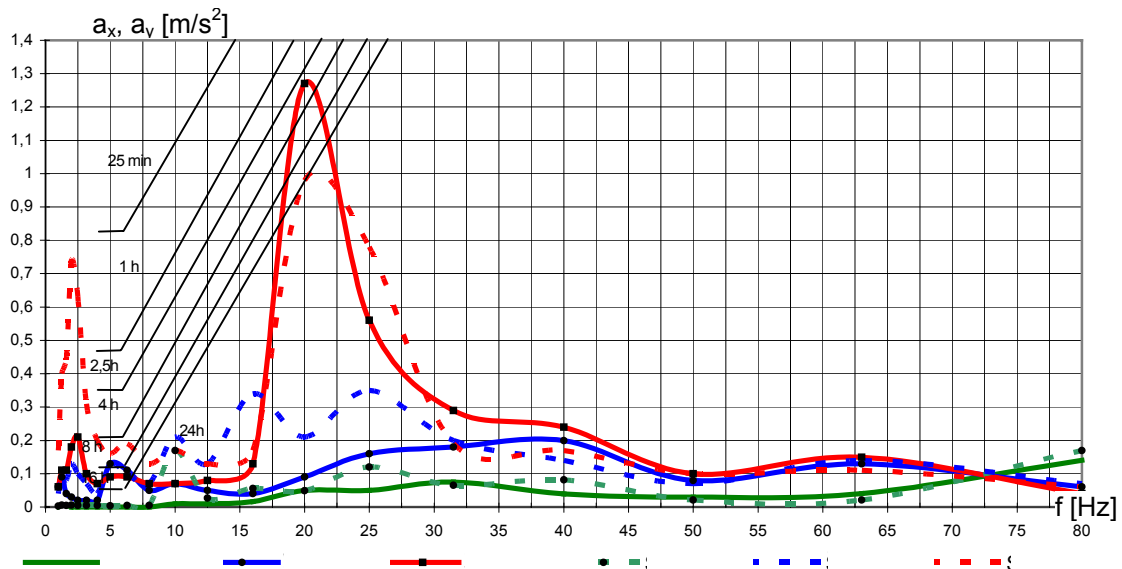


Figure 7 - Longitudinal and cross accelerations at stationary, during work and transport (LAVERDA L626 I)

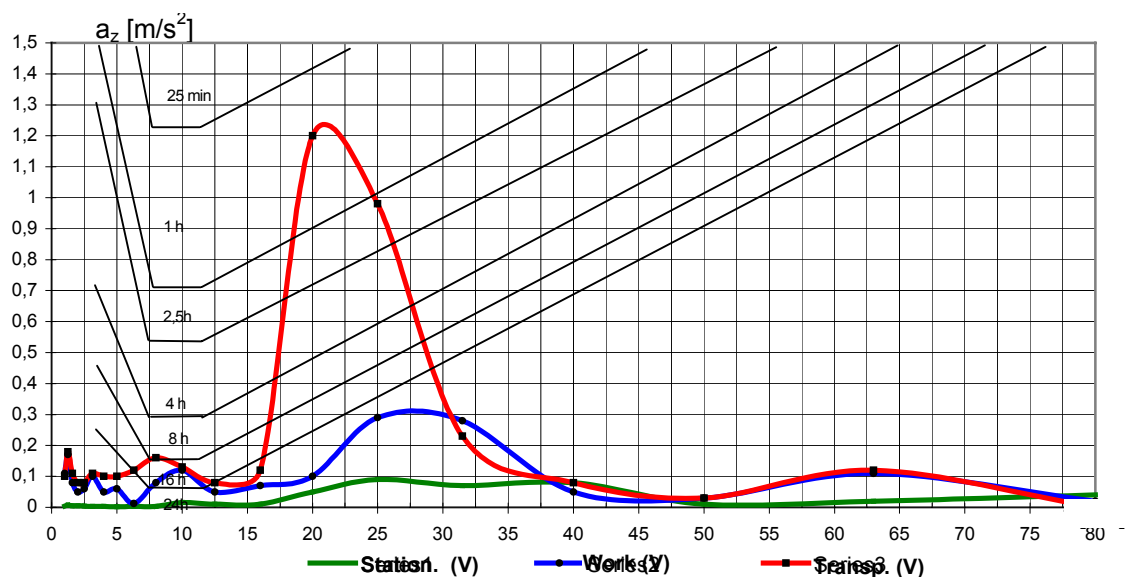


Figure 8 - Vertical accelerations at stationary, during work and transport (LAVERDA L626 I)

The results of the determinations on the vibrations sent to the chair of the harvester NEW HOLLAND TX66 are shown in table 5, figures 9 and 10. At stationary the operator can work without any danger for over 24 hours and during effective work for max. 6 hours (0.16 m/sq.s at 1.25 Hz - cross accelerations). During transport the maximum accelerations were the vertical ones, reaching the value 0.55 m/sq.s at 2.5 Hz and they result in the operator's being in danger if the harvester runs ceaselessly for over 4 hours.

Table 5 - Accelerations measured on the three directions for the harvester NEW HOLLAND

f [Hz]		1	1,25	1,6	2	2,5	3,15	4	5	6,3	8	10	12,5	16	20	25	31,5	40	50	63	80	
NEW HOLLAND TX 66	Station	L	0	0.003	0	0.003	0.003	0.003	0.003	0.003	0.003	0.005	0.005	0.006	0.011	0.02	0.015	0.044	0.046	0.044	0.021	0.053
		T	0	0	0	0	0	0	0	0	0	0	0	0.002	0.006	0.013	0.026	0.13	0.07	0.03	0.008	0.035
		V	0	0	0	0	0	0	0	0	0	0	0	0.002	0.004	0.024	0.013	0.05	0.09	0.04	0.024	0.07
	Work	L	0.045	0.068	0.03	0.04	0.06	0.05	0.03	0.05	0.06	0.18	0.04	0.09	0.09	0.13	0.07	0.23	0.09	0.07	0.07	0.07
		T	0.06	0.16	0.12	0.07	0.05	0.03	0.02	0.03	0.02	0.05	0.10	0.12	0.12	0.19	0.17	0.58	0.18	0.10	0.04	0.18
		V	0.04	0.07	0.05	0.12	0.25	0.21	0.07	0.04	0.04	0.10	0.06	0.06	0.09	0.16	0.09	0.25	0.12	0.08	0.08	0.17
	Transp.	L	0.04	0.07	0.04	0.06	0.12	0.10	0.05	0.04	0.04	0.04	0.05	0.09	0.40	0.13	0.13	0.40	0.09	0.07	0.07	0.04
		T	0.10	0.23	0.17	0.13	0.07	0.05	0.05	0.05	0.05	0.05	0.07	0.22	0.96	0.25	0.28	0.6	0.11	0.06	0.04	0.01
		V	0.07	0.17	0.16	0.27	0.52	0.55	0.22	0.09	0.07	0.11	0.12	0.12	0.40	0.17	0.20	0.35	0.12	0.10	0.11	0.06

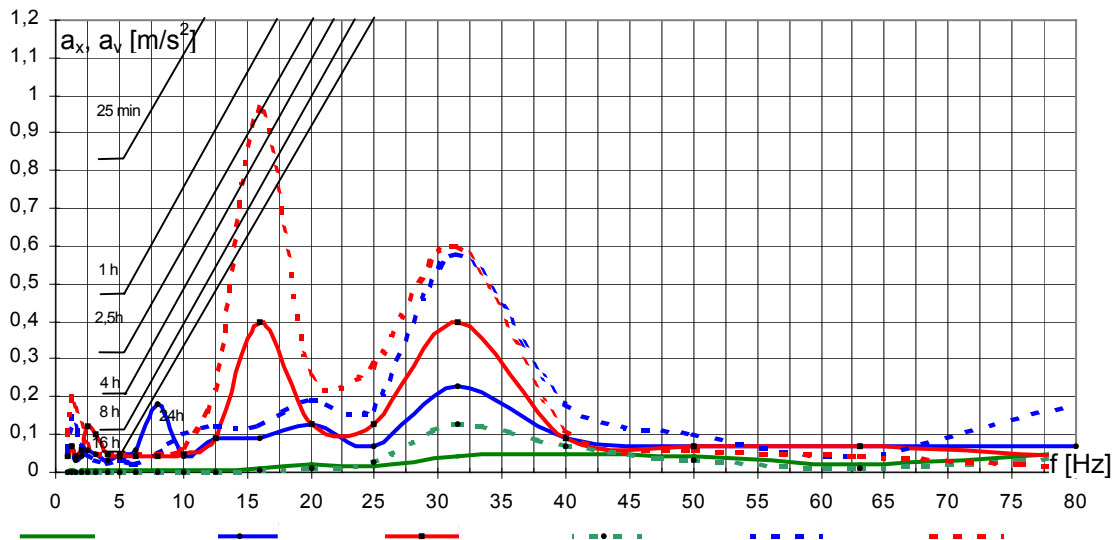


Figure 9 - Longitudinal and cross accelerations at stationary, during work and transport (NH TX)

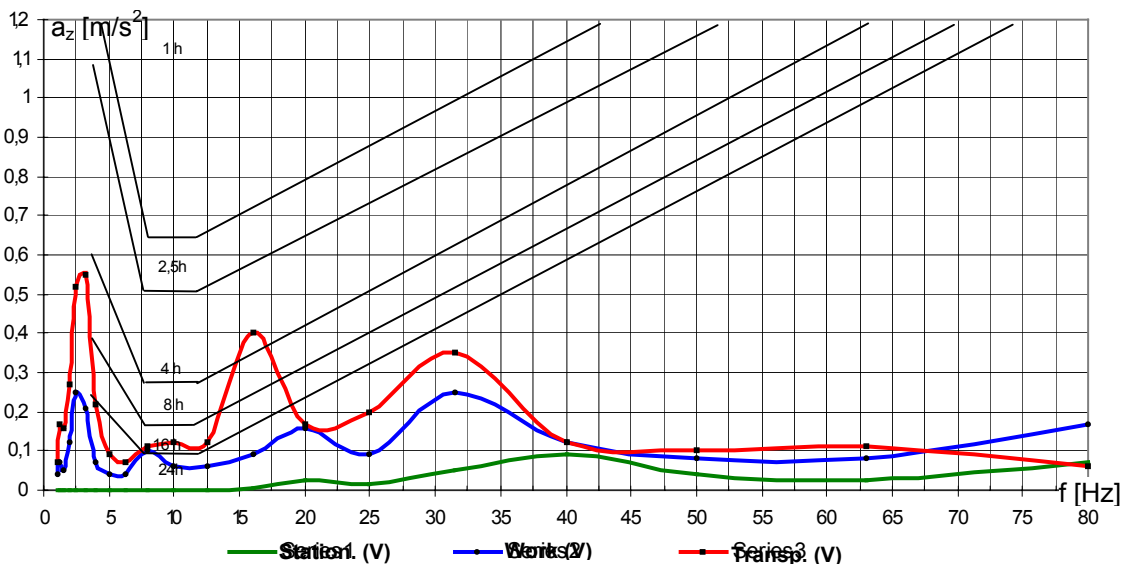


Figure 10 - Vertical accelerations at stationary, during work and transport (NEW HOLLAND TX 66)

### 3. CONCLUSIONS

From the analysis of the vibrations sent to the working parts of the five harvesters at their chair it results as follows:

- the maximum values of the longitudinal accelerations -  $a_x$  (table 1) were registered for the harvester SEMA 140M during work, and they were 0.18 [m/sq.s] at 2.5 Hz, this means that the operator can work ceaselessly, without any danger, for maximum 16 hours.
- the maximum values of the cross accelerations -  $a_y$  (table 4) were registered for the harvester LAVERDA L 6261, during transport, and they were 0.74 [m/sq.s] at 2.0 Hz, this means that the operator can work ceaselessly, without any danger, for maximum 1,5 hour.
- the maximum values of the vertical accelerations -  $a_z$  were registered for the harvesters SEMA 140M (1.44 m/sq.s at 20 Hz - table 1) and LAVERDA L 6261 (1.05 m/sq.s at 3.15 Hz - table 4), during transport, this means that the operator can work ceaselessly, without any danger, for max. 1.5 hour.

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