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MAY THE OCCURRENCE OF TRAFFIC PARTICIPANTS´ WORKLOAD BE PROGRAMMED BY THE ENGINEERS?

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ABSTRACT

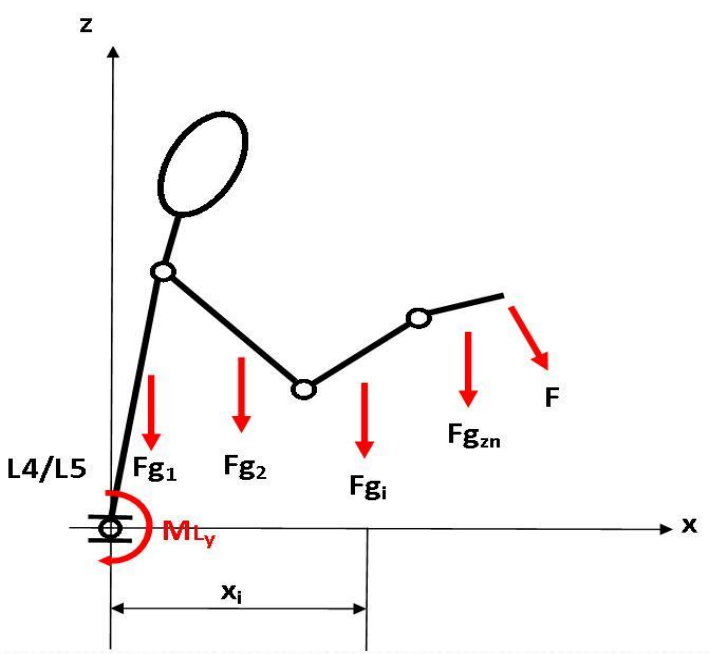
- Basic hypothesis:

Occurrence of a higher level of workload s well as a lower level of traffic participants´ performance can be caused by the simultaneous factors from working and traffic environment, which can be programmed by the engineers during the design and/or run transport processes

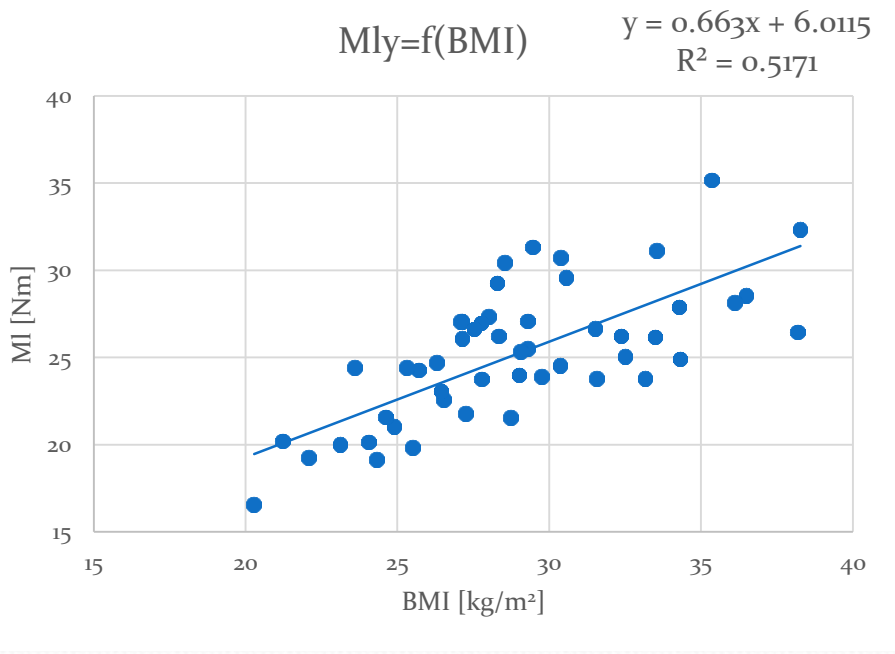
- The highlight is on the need to educate the stakeholders to create awareness of high-quality Human Factors and Ergonomics and its contributions to transport processes design in Croatia

FACTORS OF PHYSICAL WORKLOAD

- Body segment gravities F_{gzi} and the amounts of lumbar moments M_{ly} have been obtained by the reduction of all the gravities F_{gzi} into the origin of the coordinate system xy
- $F_{gzi} = m_i \cdot 9.81$
- $M_{ly} = \sum_{i=1}^{n} F_{gzi} \cdot x_i$



- Lumbar moment M_{ly} has an acceptable correlation dependence $M_{ly}=M_{ly}(BMI)$ of medium strenght ($R= 0.719$), close to the border value of R for a strong strenght
- $M_{ly} = 0.663 \cdot BMI + 6.0115$



AMBIENTAL FACTORS IN CABINS AND WORKING ENVIRONMENT

- Oldest models of trams in Zagreb without air conditioned cabs makes 23.3% of the ZET (*Zagreb Electrical Tram*) fleet, and they also run during summer,
- Potentially dangerous situation, because the poor values of the thermal comfort factors in tram cabs can have negative influence on the tram drivers´ performance and traffic safety

Tram model: manufacturer:	no.	The average age (year)	Air conditioned cab	Passengers +1 driver		
				Sitting	Standing	Σ
TMK 2100: TŽV Gredelj	16	18.13	YES	45+1	197	**243**
NT 2200: Crotram	140	9.47	YES	41+1	241	**283**
NT 2300: Crotram	2	7.26	YES	27+1	142	**170**
TMK 201* + trailer TP 591: Đuro Đaković	12 + 13	42.95 + 44.51	NO	23+1	104	**128**
Articulated TMK 301 and 354 (KT4): ČKD Praha	51	31.38	YES	25+1	147	**173**
TMK 401 (T4)* + trailer TP 801 (B4): ČKD Praha	**51 + 45**	**37.80 + 39.14**	**NO**	**20+1**	**103**	**124**

RECOMMENDED RANGES OF AMBIENT FACTORS´ VALUES

Season	Recommended ranges of ambient temperature Δt_a (°C)
Winter	20°C - 21°C
Summer	20°C - 24°C

Recommended ranges of relative humidity RH

Δ % RH	Note:	Effect on human:
30% RH – 70% RH	Δt_a = 18 °C - 24°C	Does not cause thermal discomfort
40% RH – 60% RH	Summer	A sense of thermal pleasure

Examples and recommendations for desktop illumination E (lux)

Environment:	Illumination E (lx)	Effect on human:
Cloudless and sunny day in the summer afternoon	≤ 100 000 lx	For E > 1 000 lx increased eye problems, increased risk of unpleasant reflections, sharp shadows and excessive contrast
Well-lit laboratory	1 000– 4 000 lx	
Offices for precise tasks	1 000– 2 000 lx	
Offices	400 – 850 lx	Employees prefer as comfortable

MEASURED RANGES OF AMBIENT FACTORS' VALUES - I

Shift:	Morning regular shift Aerodrome Control in Croatia Control Zagreb		
Shift start:	7:00	Shift end:	15:00
Date of measurement:	8th of June 2018	Day of the week:	Friday
Description of the value:	Air temperature t_a (C)	Relative humidity RH (%)	Illumination of work surfaces E (lux)
Minimum	23.6	41.7	303
Maximum	26.4	63.2	6244
Mean value	25.3	51.6	1327

Increased maximum and mean value of Illumination E (lux) due the large glass surfaces according to the external environment (need to install the appropriate glasses and protections)

Shift:	Late morning (regular) shift Approach and Area Control in Croatia Control Zagreb		
Shift start:	9:00	Shift end:	17:00
Date of measurement:	11th of May 2018	Day of the week:	Friday
Description of the value:	Air temperature t_a (C)	Relative humidity RH (%)	Illumination of work surfaces E (lux)
Minimum	23.5	50.4	123.6
Maximum	24.4	56.7	296
Mean value	23.9	53.2	286

MEASURED RANGES OF AMBIENT FACTORS´ VALUES - II

Shift:	**Morning regular shift**		
Shift start:	7:00	Shift end:	15:00
Date of measurement:	8th of June 2018	Day of the week:	Friday
Measurement start:	7:00	Measurement end:	15:00
Equivalent noise level L_{eq}	57.4 dB(A)	Shift duration:	8:00h

Shift:	**Morning regular shift J2**		
Shift start:	8:00	Shift end:	16:15
Date of measurement:	29th of June 2018	Day of the week:	Thursday
Measurement start:	8:00	Measurement end:	16:00
Equivalent noise level L_{eq}	65,3 dB(A)	Shift duration:	8:00h

MEASURED RANGES OF AMBIENT FACTORS´ VALUES - III

- Even though the measured noise level is higher than the ICAO recommendation, the daily noise doses *D* which *air traffic controllers* effectively accumulated in a period of regular work shift (8 hours) are symbolic

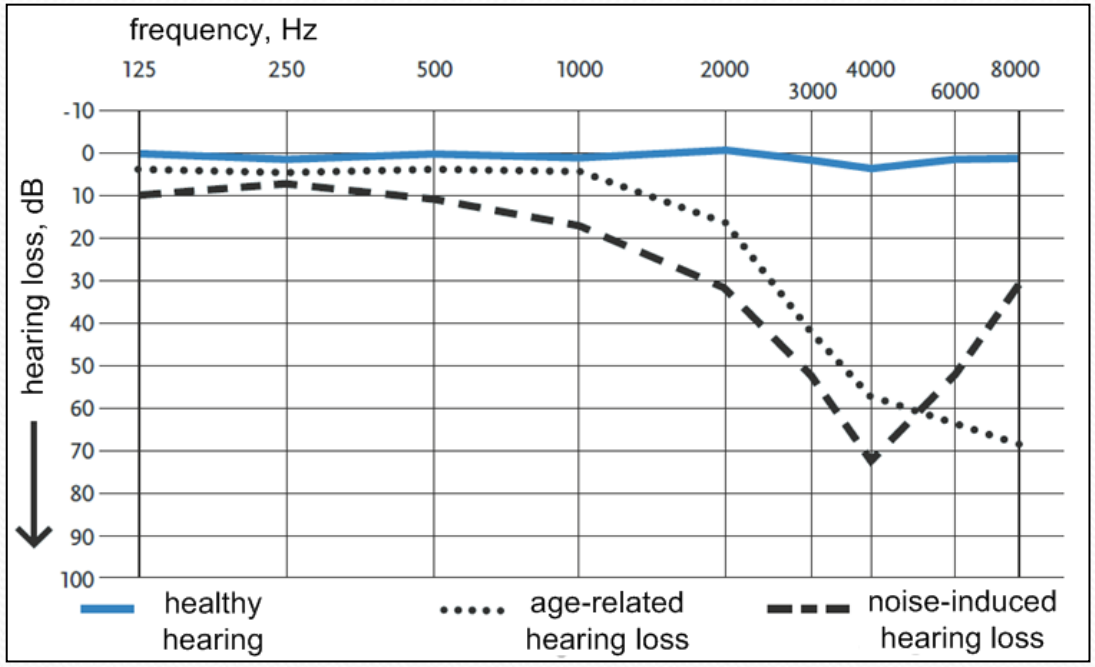
Shift:		**Morning regular shift**	
Shift start:	7:00	Shift end:	15:00
Date of measurement:	8th of June 2018	Day of the week:	Friday
Recommended daily dose of accumulated noise by NIOSH [13]: 100% D = 85 dB(A) for 8h			
Criterion level Lc: 85 dB(A)		Exchange rate EA: 3 dB(A)	
Measurement start:	7:00	Measurement end:	15:02
Accumulated (%) doses D	10.24%	Shift duration:	8.02h

Shift:		**late morning (regular) shift**	
Shift start:	9:00	Shift end::	17:00h
Date of measurement:	11th of May 2018	Day of the week:	Friday
Recommended daily dose of accumulated noise by NIOSH [13]: 100% D = 85 dB(A) for 8h			
Criterion level Lc: 85 dB(A)		Exchange rate EA: 3 dB(A)	
Measurement start:	9:00	Measurement end:	17:09
Accumulated (%) doses D	5.76%	Shift duration:	8.09h

PERMANENT THRESHOLD SHIFT (PTS)

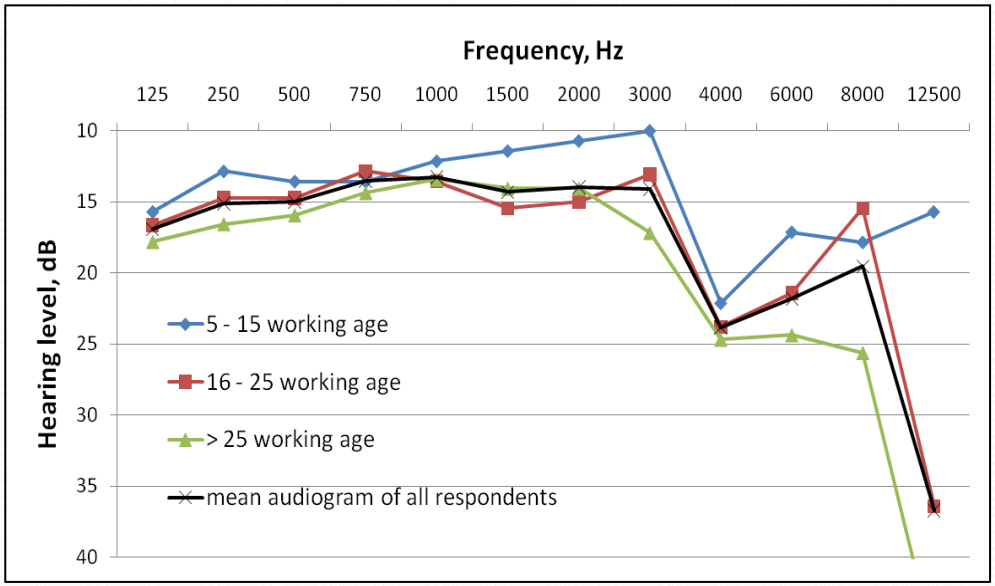
- It is important to recognize the difference between:

1. Healthy hearing
2. Age-related hearing
3. Noise-induces hearing loss (NIHL)



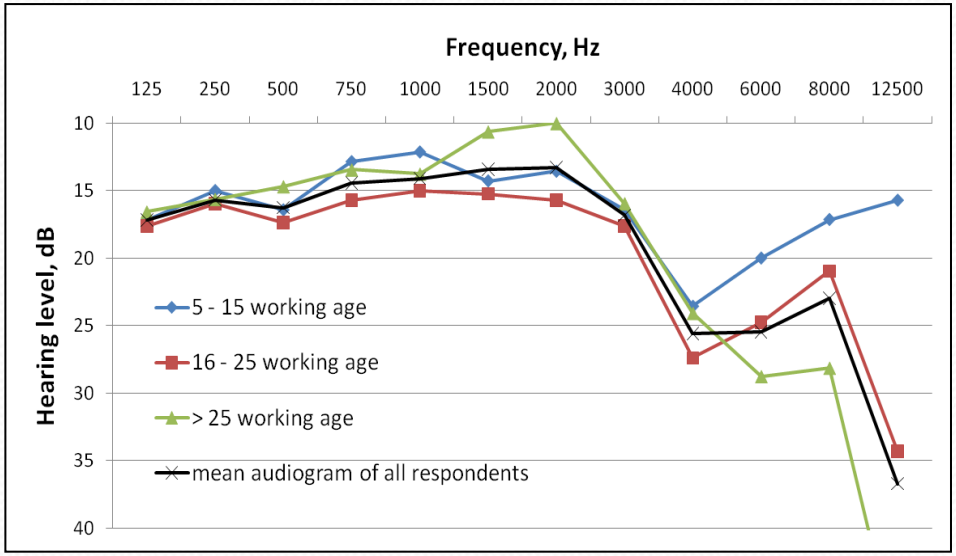
- Noise-induced hearing loss can be easily recognized by the typical notch at frequency of about 4 kHz

PTS OF MALE DIESEL TRACTION ENGINE DRIVERS



- The mean audiogram *of the right ear* for three groups of *diesel traction engine drivers* related to the working age.

- The mean audiogram *of the left ear* for three groups *of diesel traction engine drivers* related to the working age.



CONCLUSION

- The presented results of work environment analysis, working conditions analysis and characteristics of different groups of traffic participants indicate non-ergonomic situations that may be due to:
  - the lack of staff (engineers) knowledge,
  - lack of staff (engineers) experience,
  - failure to implement the recommended conditions in accordance with relevant standards and guidelines,
  - insufficiently educated engineering staff who design, run and / or supervise the mentioned transport processes.
- The highlight is on the need to educate the stakeholders to create awareness of high-quality Human Factors and Ergonomics and its contributions to transport processes design in Croatia.
- Responsible for continuous education and monitoring of all stakeholders included in the designing and running of transport processes as well as monitoring of the education institutions should be an umbrella ergonomics association in cooperation with the national ergonomics associations.