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RESEARCH ARTICLE

Contribution of Bamboo for Vibratory Comfort in Biomechanics of Cycling

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Abstract:

Background:

Vibrations in cycling produced by road irregularities could cause health problems and affect the cyclist's comfort and performance. Therefore researchers and manufacturers focus their efforts to reduce the vibrations.

Objective:

The agro materials appear to consume important properties which help in reducing the values of vibrations. This study offers a perspective on the agro materials' contribution in the bicycle design.

Methods:

Three bicycle frames were compared in two situations: (i) real locomotion conditions at three speeds 15, 25, and 35 km/h on slightly grainy road with paved sector and bumps, and (ii) laboratory conditions on a vibrating platform with frequencies ranging between 20 and 80 Hz. The used frames' materials were carbon, aluminum and agro materials (bamboo and flax).

The first protocol measured the effective values in four points of the bicycle (fork, stay, stem, and saddle) in real locomotion condition. The transmissibility was calculated between the input points of vibration and the output points in contact with the rider. The second protocol defined dynamic behavior of the three frames on a vibrating platform at the range of 20-80 Hz.

Results:

It was noted that the Root Mean Square values (RMS) were significantly higher with the agro materials in 44.4% of the cases and the values were significantly lower in 1 case (Road with 15km/h). The agro materials absorbed a significant part of vibrations in comparison to other materials (19.1%, 14.7%, and 17.2% for agro materials, aluminum, and carbon, respectively).

Conclusion:

Vibration comfort for cyclists is related to the choice of the frame. The contribution of relevant biomaterials can be relevant. Indeed, agro materials have remarkable properties for the absorption of vibrations.

Keywords: Vibration, Bike comfort, Whole body vibration, Biomechanics.

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1. INTRODUCTION

The cycling manufacturers are constantly in search of innovations to design equipment . Some of these innovations are aimed to improve the cyclists' comfort by providing new materials. The agro materials are implemented in many industrial applications such as automotive, food, sustainable energy [1]. Apart from the sustainability, agro materials have stimulating mechanical and energy characteristics like Bamboo which belongs to the family of Gramineae. More specifically Gramineae with the stem woody ones called Poaceae which is flexible and resistant. There are approximately 2300 species of bamboo pertaining to 75 kinds. Concerning its mechanical properties [2, 3] the axial tensile Young's modulus fluctuates from 5 to 25 GPa, and the axial tensile strength differs from 100 to 800 MPa, for specimens taken from the inner and outer culm. Other authors [4, 5] showed that compressive strength increases with the height of the culm and with low moisture content [4, 6]. Some studies found that [5] the compressive strength of Moso bamboo increases with height along the culm from 45 MPa to 65 MPa and [4] the flexural strength increases from 70 MPa in the green state to 103 MPa for air-dried bamboo. In cycling, comfort is partly linked to the phenomena of vibration. This phenomenon is produced by the road irregularities and the intensities of these irregularities can be high levels [7]. Alternatively, this high level can produce an increase of muscle activity in cycling [8] and significantly with the increase of the energy expenditure (oxygen uptake and lactate concentration) and ventilation compared to cycling without vibration with similar power output [9, 10]. In contrast, diseases are usually associated to hand-arm system [11 - 13] and to the knee ligaments and meniscus, lower back and shoulder [14, 15]. Thus, numerous studies have analysed the dynamic behavior of the bicycle to limit or to control the vibratory transfer. (For the assessment of this dynamic response, depending on the type of bicycle used, different studies have taken into account [16, 17] its structural characteristics [18, 19] surface roughness [16, 18], speed [16], frequencies of the vibration exposure [7] and its amplitude [20]).

One of the dominant factors in vibration transfer is the frame and this research is based on the frame study . Indeed [21], it has been studied by factor analysis that the influence of the components on vibration transfer in the hand-arm system is favored by the fork and tires while the whole body vibration is mainly due to the wheels and frame. Thus the frame can be studied (i) according to its geometry [22, 23], or (ii) the material [24 - 27]. In relations to geometry [20], a model is developed to estimate the dose of vibration to the hand-arm system. It was shown that the vibration dose can be divided by reducing the distance between the two tires of 1cm.

The focus of this article is on materials and particularly on bamboo and flax fiber. Bamboo can be considered as a unidirectional continuous fiber with reinforced composite; the distribution of its fibers across thickness of the material is gradient [28]. Damping of bamboo was studied in 1997 [2]. This study showed that the viscoelastic damping behavior of raw bamboo has larger damping coefficient in the course of torsion than during bending. A study [29] analysed the modal properties, including damping of bamboo beam. The study showed three resonance frequencies associated with loss factor in the band 0-400Hz. The values depend largely on the specimen of bamboo. The application of bamboo damping properties could be noteworthy in cycling. It is worth mentioning that these studies must be completed with other research in real conditions. This paper compares the contribution of this agro material coupled with flax fiber for the design of a bicycle frame on three road profiles. This frame is compared with an aluminium and a carbon frames used commercially.

2. MATERIALS AND METHODS

2.1. Subject

One healthy trained male cyclist (1m73, 70kg) was volunteered to participate in the study, which was approved by the local university ethics review board in agreement with the declaration of Helsinki. The participant was aware of the purpose of the study, and a written informed consent was provided. The exclusion criteria included a history of back pain, acute inflammation in the pelvis and/or lower extremities, acute thrombosis, recent fractures, recent implants, gallstones, kidney or bladder stones, any disease of the spine, peripheral vascular disease, and severe delayed onset of muscle soreness in leg muscles was evident.

2.2. Material

Three frames including aluminium, carbon and agro-material were tested Fig. (**1**). The frame in agro material was made of bamboo to the upper tubes, oblique seat and the stays. A flax fiber and epoxy resin 56% bio-sourced was used for connections between each bamboo beam. The components which equipped the bicycle frame were identical for each configuration of the study. To ensure identical clamping the assembly was carried out with a torque wrench. The characteristics of the frames and peripheral devices are listed in Table **1**.

(a) (b) (c)

Fig. (1). Tested bicycles: (a) Agro-material frame, (b) Aluminium frame, (c) Carbon frame.

Table 1. Bike frames and components.

Frame	Agro Material	Aluminium	Carbone
Weight (kg)	9.0	8.5	7.9
Wheels	Corima carbon, tubeless tire MCC S+		
Tyres	Continental 23mm		
Seat	San marco Aspide carbone FX team open		
Fork	3T Funda Pro		

Four IMU (Inertial Mouvement Unit) HIKOB Fox (Villeurbanne, France) validated in the study of [30] were fixed in the bicycle. Two sensors were on the bottom of the fork and the stays, which were considered as inputs. Two sensors were on the stem and over the seat considered as outputs due to the point of contact with the human body Fig. (**2**). In the second protocol which was presented in the section 2.3, a fifth IMU sensor was set in the middle of the vibratory plate. The sampling rate was chosen at 1344Hz with an amplitude range of +/- 16g.

(a) (b) (c) (d)

Fig. (2). Positon of IMU Sensor on (a) seat, (b) stem, (c) stay and (d) fork.

2.3. Protocols

The study was composed of two protocols. The first protocol was to assess the effective values in real conditions on 3 types of sectors: slightly rough, paved and with speed bump Fig. (**3**). These sectors were flat. Twenty measures were performed on each sector at the speeds of 15, 25 and 35km/h. Rest of 1 minute was allowed in between each try. Speed was visually controlled by the rider on a counter (Sigma BC 16.12, Decathlon, France). The second protocol analysis was to determine the vibration response of the bike on a vibratory plate in the laboratory. Rear and front wheels were positioned sucessively on the middle of the vibratory plate. The plate had a vertical oscillation amplitude of 2mm (600 FITVIB, Germany). It was controlled by an acquisition system OROS OR35 (OROS, Grenoble, France) to perform a swept sinus in the range of 20-80Hz with steps at the range of 2 Hz.

(a) (b) (c)

Fig. (3). Road sectors: (a) Paved, (b) slightly rough and (c) Speed bump.

For protocol 1, the signals were collected during 5s, 3s, and 2s for speeds of 15, 25, and 35km/h, respectively, which corresponded to 6720, 4032 and 2688 samples and with the same distance of 21m. This distance included each evaluated sector. The hypothesis was made that the directions of the IMU sensors were similar during the measurements. . Thus, the average values of $\bar{x}, \bar{y}, \bar{z}$, were subtracted from the recorded signal x(n), y(n), z(n), for each axis because it reflected the gravity. Afterward, the two parameters were calculated: the total root mean squared (RMS) for each measurement points, shown in equation (1), and the transmissibility coefficient T_{ij}, shown in equation (2). The Tij was calculated as the ratio of the RMS value with the seat or stem and the fork or stay. Following the Shapiro Wilk test of normality in frequentist statistics, significant differences between the frames were evaluated by Student's t-tests. The statistically significant level was selected to 0.05 ($p<0.05$). Results are presented as mean ± standard deviation.

$$RMS = \sum \frac{(x(n)-x)^2}{N} + \sum \frac{(y(n)-\bar{y})^2}{N} + \sum \frac{(z(n)-z)^2}{N} \quad \textbf{(1)}$$

$$T_{ij} = \frac{RMS_i}{RMS_j}, i: seat\ or\ stem, j: fork\ or\ stay \quad \textbf{(2)}$$

For Protocol 2, the signals were collected during 5s within a samplig rate of 2560Hz during a stationary condition of the plate. The average value was subtracted from the recorded signal for each axis x, y, z since it reflected the gravity. Next, the RMS values were computed for all IMU positions, equation (1). Lastly, for each excitatory frequency f, the ratio between RMS value of the wheels and the 4 measurement points were calculated. The transmissibility functions were deduced in the range 20-80Hz, $T_{lab,ij}(f)$, (equation 3). These functions are dependent on the frequency f generated by the vibration platform. An amplification of the input was obtained for transmissibility values above 1. After testing the normality of the data by the test of Shapiro Wilk, significant differences between the frames were evaluated by Student's t-tests. The statistically significant level was selected to 0.05 ($p<0.05$). Results are presented as mean ± standard deviation.

$$T_{lab,ij}(f) = \frac{RMS_i(f)}{RMS_j(f)}, i: seat\ or\ stem, j: fork\ or\ stay \quad \textbf{(3)}$$

3. RESULTS

3.1. Real Conditions

The RMS values which were measured at the four points of measurement are listed in Table **2**. The results show a significant difference between the 3 road profiles and between the 3 speeds. The values of 95% increased in between 15 and 25km/h and values of 56.9% increased in between 25 and 35km/h. The increase in the RMS values by 174% between the speed bump and the slightly rough road and the 359% in between paved road and the slightly rough road were evident. In 38.9% of cases, there was a significant difference in between the aluminium frame and the agro-material frame, and in 50% of cases, there was a difference between the carbon frame and agro-material frame. In the case of "slightly rough road to 15km/h", 1.4% had a significant difference in favour of the agro. It was noted that the significant differences were 41.7%, 54.2% and 37.5% at speeds of 15, 25 and 35 k/h, respectively. The significant differences in the stem, seat, fork, and stay were 33.3%, 55.6%, 27.8% and 61.1%.

Table 2. RMS values, in m/s^2, measured on stem, seat, stay and fork. The p–value indicates the significance of the test between aluminium or carbon frame and agro material frame.

		Agro-Material		Aluminium			Carbon		
STEM	Sectors	m	std	m	std	p-value	m	std	p-value
15km/h	Road	2.13	0.20	2.26	0.17	0.03	2.05	0.13	0.15
	Cobblestone	9.00	0.84	8.96	0.75	0.92	8.47	0.69	0.14
	Speed bump	5.14	0.49	4.95	0.39	0.19	4.73	0.43	0.01
25km/h	Road	3.26	0.26	3.20	0.30	0.52	3.17	0.36	0.35
	Cobblestone	19.51	1.74	17.65	1.19	0.01	17.33	1.27	0.00
	Speed bump	10.93	0.91	10.24	1.19	0.05	10.38	0.91	0.06
35km/h	Road	5.28	0.54	5.17	0.48	0.52	4.92	0.52	0.04
	Cobblestone	27.41	1.7	27.17	2.38	0.80	26.23	2.03	0.16
	Speed bump	18.23	0.87	17.74	1.75	0.27	18.04	2.41	0.75
SEAT	Sectors	Agro-Material		Aluminium			Carbon		
15km/h	Road	1.93	0.18	1.90	0.14	0.52	1.97	0.12	0.41
	Cobblestone	7.57	0.58	7.41	0.51	0.51	7.08	0.43	0.04
	Speed bump	4.70	0.69	4.36	0.57	0.10	4.27	0.58	0.04
25km/h	Road	2.88	0.23	2.73	0.24	0.05	2.95	0.33	0.40
	Cobblestone	16.22	0.8	15.01	0.98	0.01	14.93	1.04	0.01
	Speed bump	10.25	0.84	9.24	1.21	0.00	9.56	1.11	0.03
35km/h	Road	4.85	0.45	4.79	0.36	0.66	4.80	0.46	0.73
	Cobblestone	24.90	0.3	24.59	1.52	0.59	23.44	1.24	0.01
	Speed bump	17.63	1.56	16.33	1.91	0.02	16.45	1.89	0.04
FORK	Sectors	Agro-Material		Aluminium			Carbon		
15km/h	Road	2.81	0.28	2.91	0.21	0.22	2.84	0.17	0.72
	Cobblestone	11.09	0.85	10.74	0.87	0.37	10.08	0.75	0.01
	Speed bump	5.97	1.16	5.55	0.29	0.13	5.60	0.39	0.19
25km/h	Road	4.41	0.36	4.20	0.39	0.09	4.30	0.46	0.40
	Cobblestone	28.41	2.76	24.77	2.64	0.01	21.58	1.75	0.00
	Speed bump	11.66	1.09	11.07	1.30	0.13	11.30	0.77	0.23
35km/h	Road	6.77	0.79	6.66	0.60	0.61	6.12	0.64	0.01
	Cobblestone	37.08	1.91	36.00	3.18	0.37	29.96	1.53	0.00
	Speed bump	20.00	1.11	19.51	1.79	0.30	20.01	1.97	0.99
STAY	Sectors	Agro-Material		Aluminium			Carbon		
15km/h	Road	3.01	0.23	2.33	0.15	0.00	2.52	0.13	0.00
	Cobblestone	8.33	0.51	7.94	0.46	0.09	7.90	0.36	0.04
	Speed bump	5.66	0.65	4.89	0.58	0.00	4.99	0.69	0.00
25km/h	Road	4.75	0.33	3.51	0.26	0.00	3.96	0.35	0.00
	Cobblestone	16.54	0.72	15.84	1.19	0.13	16.79	1.33	0.61
	Speed bump	11.42	0.69	10.19	1.17	0.00	11.22	1.22	0.53
35km/h	Road	6.98	0.49	5.76	0.37	0.00	6.24	0.52	0.00
	Cobblestone	26.72	1.19	26.66	2.01	0.94	26.33	1.59	0.55
	Speed bump	19.64	1.63	18.20	1.80	0.01	19.33	1.89	0.59

The transmissibilities values are given in Table **3**. The values are inferior to 1 which shows that frames did not amplify the vibratory level recorded at the bottom of the fork and the stay. Mean transmissibilities were 80.9%, 85.3% and 82.8% for frames in agro materials, aluminum and carbon, respectively. The table demonstrates that 37.5% of cases have a significant difference between aluminum or carbon frames and agro materials frame for the benefit of agro materials. In particular, the transmissibility between the stay and the seat or the stem for the agro materials frame was significantly lower than the aluminum frame regardless of road and speed conditions and it was significantly lower than the carbon frame for speed 15km/h. Transmissibilities between the fork and the seat or stem were not significantly different except for the carbon at 35km/h.

Table 3. Transmissibility coefficients.

Fork - Stem	**Agro-Material**		**Aluminium**			**Carbon**		
	m	std	m	std	p-value	m	std	p-value
15km/h	0,82	0,08	0,83	0,06	0,18	0,79	0,07	0,17
25km/h	0,81	0,11	0,82	0,09	0,64	0,82	0,09	0,49
35km/h	0,83	0,09	0,83	0,08	1,00	0,86	0,07	0,04
Stay- Stem	Agro-Material		Aluminium			Carbon		
	m	std	m	std	p-value	m	std	p-value
15km/h	0,86	0,15	1,02	0,08	0,00	0,92	0,12	0,03
25km/h	0,89	0,19	0,99	0,08	0,00	0,90	0,10	0,89
35km/h	0,88	0,12	0,95	0,08	0,00	0,89	0,11	0,74
Fork - Seat	Agro-Material		Aluminium			Carbon		
	m	std	m	std	p-value	m	std	p-value
15km/h	0,73	0,09	0,71	0,08	0,31	0,72	0,07	0,66
25km/h	0,73	0,13	0,72	0,10	0,59	0,75	0,09	0,30
35km/h	0,78	0,11	0,76	0,09	0,46	0,80	0,06	0,15
Stay- Seat	Agro-Material		Aluminium			Carbon		
	m	std	m	std	p-value	m	std	p-value
15km/h	0,77	0,11	0,87	0,05	0,00	0,83	0,05	0,00
25km/h	0,80	0,16	0,86	0,07	0,01	0,82	0,07	0,43
35km/h	0,82	0,11	0,88	0,04	0,00	0,83	0,05	0,90

3.2. Laboratory Conditions

Prior to the calculation of the transmibility functions, the frequency ranges of the vibratory plate compared to road profile were validated. Fig. (**4**) shows the time signal to 3 seconds and its spectrum on the range 0-200Hz for the three field conditions. For this exemple, 95% of the spectrum was in the 15-72Hz range. There was a structural resonance on 120-180Hz amplitude range less than 0.1m/s.

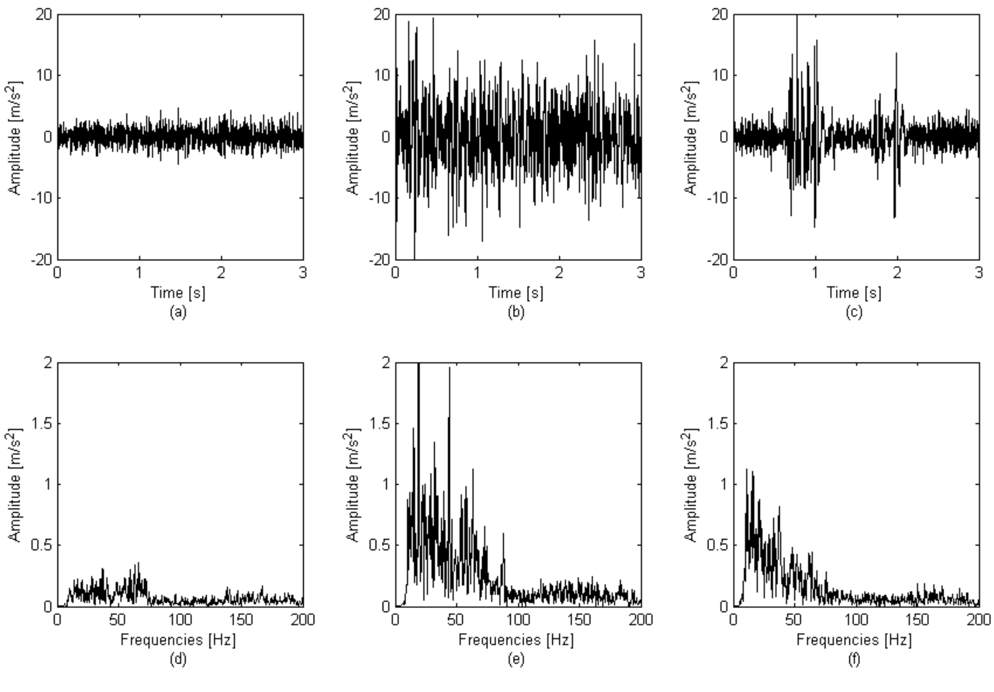

Fig. (4). Example of time signal (a,b,c) and its spectra (d,e,f) on slighty rough road (a,d) on paved sector (b,e) with speed bump (c,f) at 25km/h for the agro material bike.

An analysis of the median frequency in Table **4** indicates that the frequency values of the requested range decreased with the speed for the three frame. On the slightly rough road, the median frequencies were 65.5, 41.4, and 38.3Hz for speeds of 15, 25 and 35 km/h, respectively. On the paved sector, the median frequencies were 32.3, 36.1, and 39.5Hz for speeds 15, 25 and 35km/h, respectively. The speed bump showed median frequencies of 27.5, 28.2, and 28.5Hz for speeds 15, 25 and 35km/h, respectively. These results justify the use of the vibratory plate ranging fromrange 20-80Hz representing 92% of the excited range on the field.

Table 4. Median frequencies (Hz).

Speed	Sectors	Agro Material		Aluminium		Carbon	
		m	std	m	std	m	std
15km/h	Road	63.0	6.4	67.6	3.9	65.8	3.2
	Cobblestone	31.2	4.0	32.5	2.24	33.1	3.4
	Speed bump	24.9	4.1	27.8	4.9	29.8	6.44
25km/h	Route	40.8	2.7	41.3	3.5	42.1	4.8
	Cobblestone	37.5	0.7	36.4	0.8	34.3	1.7
	Speed bump	29.0	4.2	27.9	3.5	27.7	3.1
35km/h	Road	37.6	3.5	38.6	3.6	38.7	4.5
	Cobblestone	40.8	1.5	40.0	2.9	37.8	2.6
	Speed bump	29.5	3.4	27.8	3.1	28.1	3.5

The transmissibility functions between the rear and the front wheels and the four measurement points are listed respectively in Figs. (**5** and **6**), respectively. An amplification of the input signal on a certain frequency range is highlighed which shows that the ranges are having a transmissibility superior to 1. Those ranges of amplification were 32-52Hz at the fork, 40-50Hz at the stem, 35-50Hz at the stay and 40-47Hz at the seat. There was a further range in between 55-65Hz for aluminum at the fork. Aimed at the sollicitation on the front wheel, the amplification was more important for agro material frame than the other two frames intending a wide frequency range. Nevertheless in the range of 55-65Hz it has similar characteristics to the carbon while the aluminum frame amplified the exposure level. For a sollicitation on the rear wheel, the 3 frames had similar transmissibilities behaviors over the range studied.

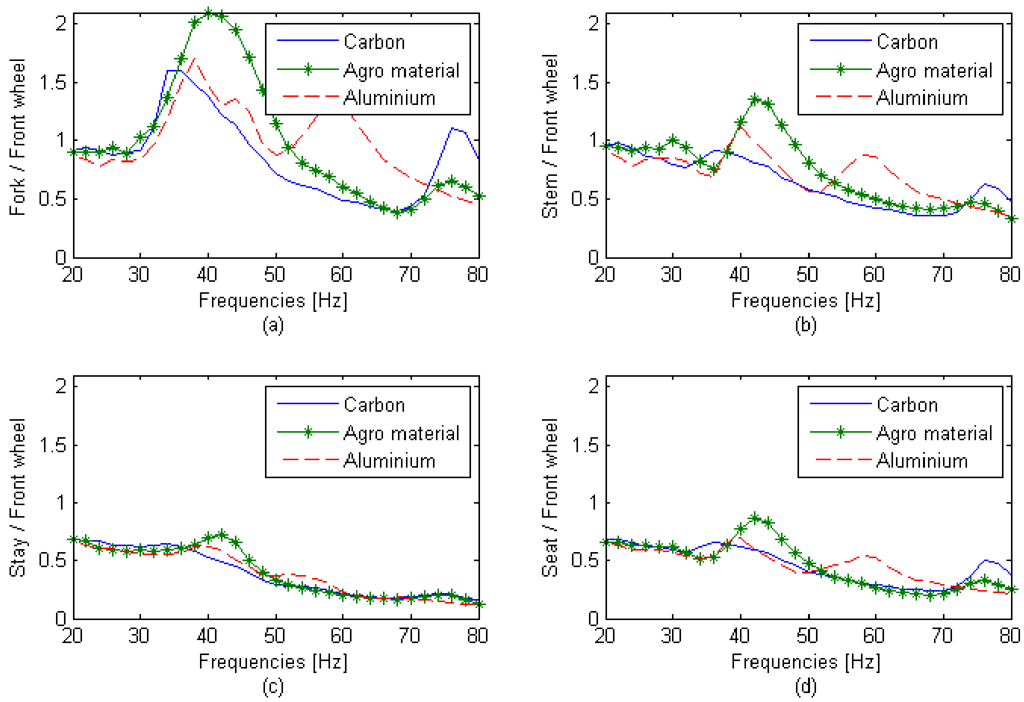

Fig. (5). Transmissibility function between front wheel and (a) fork, (b) stem, (c) stay and (d) seat.

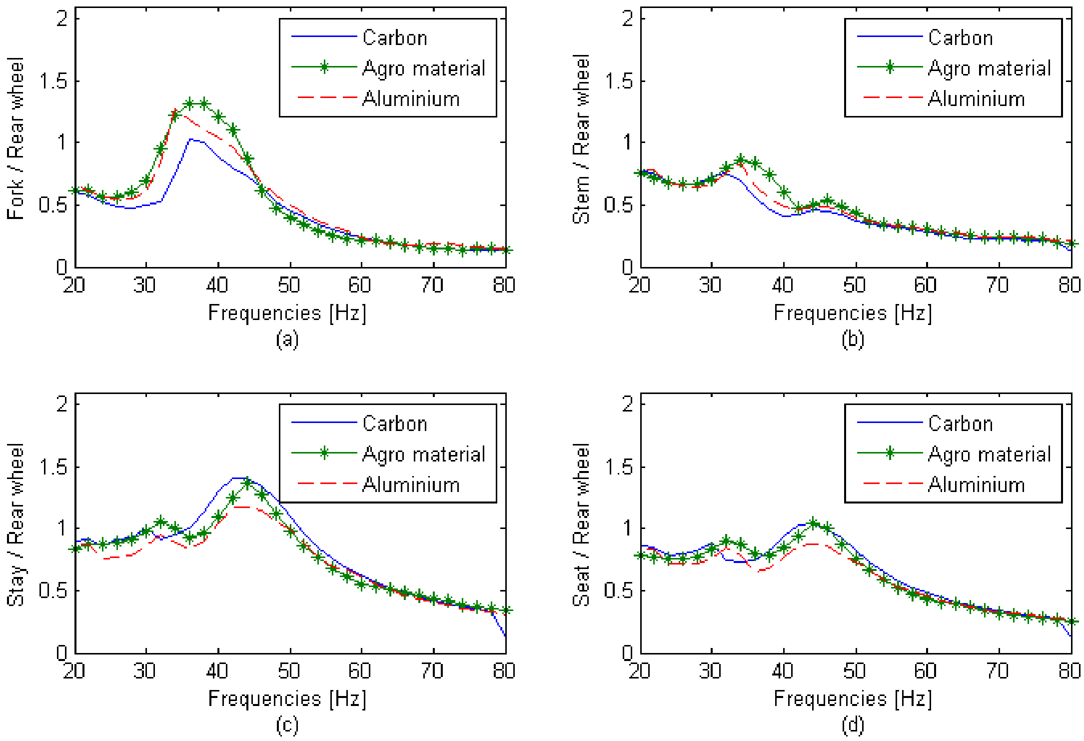

Fig. (6). Transmissibility function between rear wheel and (a) fork, (b) stem, (c) stay and (d) seat.

4. DISCUSSION

As shown by numerous studies [16, 18] the exposure level is different on the three road profiles with respect to high values on the pavement profile. The speed also has an impact on vibratory levels recorded. The level is increased between 56.9 and 95%.

The analysis of the RMS values allowed to compare the three bike frames and showed that the values were lower for carbon. The agro material frame had the higher results with one single condition of comfort gain (15km/h on slighty rough road compared with the aluminum frame). This fact was related to the solicitation of median frequency of 65.5Hz and amplification range of 55-65Hz for the aluminum frame highlighted by the laboratory protocol. On a slighy rough profile, the agro material frame had properties which were similar or better than aluminium. In contrast, the agro material frame had low characteristics at the speed of 25km/h, which is highlighted by the laboratory protocol and the median frequencies. At this speed, the median frequencies were between 28.2 and 41.4Hz. This fact coincides with the high amplification factors for the agro material frame (amplification value reaching 2.1 against 1.6 and 1.5 for the other two frames). The agro material frame appeared to remain penalized by the attachment between the wheel and the stay. The vibration level was excessive compared to other frame which affected the vibratory level received at the seat. In general the stay had a vibratory level of 14% higher than carbon or aluminum. This increase was only 7% in the seat which may explain the effect of the stay itself. Vibration doses were in between 9% to 18% higher at the wheels compared to other two frames nonetheless these levels were in between 7% and 9% only for seat and stem, respectively. This result indicated that the agro material frame had excellent properties in the transmission of vibrations but it has higher RMS values.

The analysis of the transmissibility confirmed that the agro material frame had a better absorption than the aluminum frame particularly between the stay and seat/stem. This result was in correspondence with another work [31]. In general, it had the same damping properties as a carbon frame; however, showed better results for some speeds. The transmissibilities average values of 0.88 in between the stay and the stem, 0.82 in between the fork and the stem, 0.75 in between the fork and the seat, 0.80 in between the stay and the seat, were obtained. From seat stay, an absorption gain was noted for the agro material frame compared to aluminium frame (9%) and compared to carbon frame (2%). The transmissibilities of the vibratory stressed from the fork were identical to the three frames. This could be explained through the preponderance of the absorption by the fork. The fact is confirmed by a study [21], where it was shown that the fork and the frame were highly pertinent elements in the transmission of vibrations. The transmissibility functions resonanced frequencies range were 30-50Hz for the wrist, 16-30 Hz for the forearm, 20-90Hz for the eyeball and 10-12Hz for spine [32]. Carbon frames and aluminum were preferred for disease prevention at the wrist, forearm, and visual performance. It was noted that the aluminum frame can affect the eyeball more broadly because of its modal properties superior to 55Hz. The effect on the spine could not be treated here due to the mechanical limitations of the bench. The bench could not generate frequency under 20Hz yet, spectral analysis revealed the vibratory stresses superior to 15Hz on field conditions.

4.1. Recommendation/Perspectives

Although the agro material frame did not have significantly different vibration characteristics in 55.5% of cases, this non-optimized frame was very promising. According to the results, it is recommended to modify the design at the connection between the hub and the stay. The junction in front of the frame and in between the fork and the stem can be optimized to compensate the vibratory amplification, however, the level is higher than the other two frames. These changes would affect the general behavior of the frame. The optimization involved the natural geometry of bamboo. Currently there is a need for empirical and numerical studies which could bring more information including the selection of thicknesses, the position of the nodes, the length of the internodes, and the position of the reinforcement with flax fiber. The contribution of the modal analysis could help to understand the natural deformation of the frame in particular, medio-lateral plane.

This study is subject to two bias. First bias indicates that the bikes' masses were different at 5.6% and 12.2% less for aluminum and carbon frames, respectively. However, these differences cannot explain the dissimilarities in doses only because according to Newton's second law, acceleration increases with decreasing mass for identical stress forces. The second bias is related to the repeatability of the agro material production frame. Are the results similar between two identical agro material frames knowing that production is handmade?

CONCLUSION

Vibration comfort for cyclists is related to the choice of the frame. The contribution of relevant biomaterials could be relevant. Interestingly enough agro materials have the ability to absorp vibrations. This paper focused on the study of bamboo use and flax fiber to design a road bike frame. The study was achieved by comparing the dynamical behavior of three frames on 3 road profiles: slightly rough, speed bump and cobblestones. The comparison with aluminum frame and carbon frame showed an absorption rate higher for agro materials (9% compared to aluminum and 2% compared to carbon), Nevertheless the tested bike had higher vibration dose level on the inputs (fork and stay). This fact showed that the design should be redefined. The contribution of agros materials reduces the transfer function yet the frame should be optimized, and in particular weight needs to be decreased.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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