Construction of a multi purpose leisure building biology essay

Art & Culture, Dance

The intent of this program is to hold an lineation of process and method in topographic point so work can get down directly off in Semester 3. After the program, this papers contains a preliminary background reappraisal depicting how aims can be achieved.

As this is a preliminary study of the literature it can be updated as the undertaking progresses into a full literature reappraisal ; nevertheless, it will supply plenty of an apprehension to get down the thesis work. Besides in this program is an intended agenda of work and clip required. 1. 2 The ProblemPlanned new building of a multi-purpose leisure edifice was due to be finished and opened in 2009. The new chances provided for the seaside town were delayed nevertheless due jobs with the design. The two floor edifice acquired be aftering permission to house a bowling back street along with retail stores, coffeehouse and eating houses etc, and a leisure and conference suite along with roof patios for positions of the sea, every bit good as map suites available to engage for nuptialss etc.

On the first floor, above the bowling back street and stores is where the extra map suites are to be situated. During building of this suspended floor over-size quivers were noticed. The job arises in that this floor will be receptive of crowd dynamic burden from the assorted utilizations and so was thought to be incapable of accepting such burden bearably. The coordinated motions of groups of people from dance, aerophilic and gymnasium type activities were non decently considered in an equal design quiver cheque, taking to jobs going seeable. The University of Sheffield Vibration Engineering Section (VES) were employed to dynamically prove the

construction taking to a solution of the job. 1. 3 Undertaking ProposalIn short the undertaking proposes to analyze the floor from the design phase, through to the dynamic testing consequences and come up with a feasible solution for the construction ‘ s jobs. First research will be required into accurate ways pattern this type of dynamic burden and any relevant design codifications of practise, this will be included in a full literature reappraisal.

Second the building of an FE theoretical account in ANSYS to which this lading simulation can be applied. Third, it is proposed to measure the theoretical account ‘ s utility against the experimental informations available from the VES. This information can besides be used to update the FE theoretical account after comparing. With a working theoretical account it is so planned to come up with a declaration to the job and prove the result. Last, as an excess enterprise, an analytical theoretical account of the job utilizing manus computation is planned. The opportunity to make a to the full working FE theoretical account and validate against the VES trial informations for a existent life construction provides principle for the undertaking. 1. 4 Outline PlanThis subdivision describes the general attack to the undertaking.

1. 4. 1 DeadlinesThe needed chief deadlines of the undertaking are: DateDeadline28th May (09. 00)Preliminary presentation – 4 proceedingss14th June (14. 00)Dissertation program – this papers – 15 – 20 pages3rd September (12. 00)Dissertation entry – 2 edge transcripts and a PDF6th – 10th SeptemberDissertation interviewseventh September (17.

00)Conference paper – maximal 6 pagestenth September (14.

00)Conference presentation entry14th SeptemberTechnical conference – 12 minute presentationTable 1: Deadlines1. 4. 2 Pre-ModellingBefore any computing machine modeling begins a reappraisal of the relevant design codifications and guidelines needed to be carried out. A brief overview of the findings is given in Section 2. This was a cardinal phase in the undertaking ; as come oning with any facet was otherwise impossible, guidelines being the lone manner to do certain loading/models are created in a realistic manner by trusting on past research consequences. By the terminal of semester two (i. e.

given in the background reappraisal in subdivision 2) there should be plenty researched information into: Formulations of using ladingWayss to use this in ANSYSThe analyses required from the FE packageMethods of quantifying this analysis into ‘ yes ‘ or ‘ no ‘ acceptablenessBettering quiver features of a construction1. 4. 3 ModelingThe FE modeling of the floor is expected to take a important sum of clip (adding the consideration of negligible experience with the package,) it could be the most of import portion of the undertaking.

To near this in a methodical manner the undertaking was split into four countries ; Start with ANSYS – basic operations/functions tutorials and little technology jobs from cyberspace sites and aid tutorials, this was completed by the terminal of the Easter holiday period. Structural usage of ANSYS - practise/research into different theoretical account types and methodological analysiss with conjectural floor state of affairss, and carry out average analyses. To be completed by the terminal of semester 2. Model leisure

Centre floor – preliminary efforts at the undertaking theoretical account utilizing the given CAD drawings to do. dat input books.

To be built up in complexness in a consecutive mode for treatment with supervisor or phD pupil adviser at each degree if required. Apply loads – when a sensible theoretical account is made apply walking/ leaping tonss and group jumping tonss for analysis. These tonss are discussed further in subdivision 2.

2, every bit good as the acceptable standards for design for which they should be measured against in subdivision 2. 3. 1. 4.

4 ValidationWhen the FE theoretical account is complete and it is believed that equal modal consequences have been acquired the VES average trial informations will go available. At this comparing phase it will be possible to understand any short approachs of the theoretical account and analyze the grounds for them. Besides the quiver trial consequences from VES can be compared to the laden theoretical account. Evaluations are likely to be made with acceleration response secret plans and modal belongingss. 1.

4. 5 Remedial MeasuresAfter sufficient proof and updating, it should be clear what the cause of the quiver serviceableness jobs are. It would be utile here to observe how responsible the design advisers were with the design, did they do big misjudgements, ignore guidelines, make apprehensible mistakes, or were there jobs with the construction/assembly facet.

From the research done it should besides be clear what options are available to work out these jobs. If necessary, farther structural elements will be designed and added to the FE theoretical account to turn out their effectivity. 1. 4. 6 Time ManagementAs agreed with the supervisor there will be meetings on approximately a biweekly footing to reexamine advancement but for smaller issues related to ANSYS advice from a phD pupil will be made available. Over the full semester it is planned to remain in Sheffield and work a normal working hebdomad. This should besides let for a summer interruption period.

It is utile to see the work agenda in timeline format for which an A3 size Gantt chart is given as Appendix B. 1. 5 Present SituationAs there was no anterior experience with ANSYS, the get downing point was the absolute rudimentss. The constitutional tutorials were run through to give an apprehension of the general user interface. Appendix A contains screenshots of the theoretical accounts created for developing with conjectural floors. Oasys GSA was besides used aboard ANSYS as the plan is more intuitive and aided acquisition in general.

Modal analyses were carried out every bit far as possible to acquire meaningful consequences. A great trade was learnt by making these theoretical accounts (for illustration the restrictions of the academic version of ANSYS) . It is presently understood that ANSYS is the lone package realistically suited for the analysis. Alongside the chief theoretical account it is hoped to bring forth another working theoretical account in GSA. It is to a great extent marketed as successful quiver analysis package and would be

interesting to compare some consequences, without allowing this take up excessively much important clip. Combined with research this would hopefully develop cognition of the grounds why merely some package bundles can give meaningful consequences and serve as a good general cognition footing for the hereafter. 1.

6 DeliverablesThe concluding deliverables of CIV 6020 & A ; 6000 are ; A proficient conference paper and presentation and, A thesis papers of maximal 80 pages, this is to incorporate chapter headers based around the undermentioned model in table 2 ; No. ChapterMain Sub-headings1Introduction1. Problem2. Outline of Undertaking2Background and Literature Review1.

Current Requirements on Design2. Vibration Serviceability of Floors. 3.

FE Modelling of Floors4. Modeling Human Dynamic Human Loading5. Acceptability of Vibrations6.

Extenuation of Vibrations3FE Modeling1. Premises2. Meshing/ Material Properties/ Boundary Conditions/ Geometry3. Analysis Consequences4. Discussion4ValidationModal TestingModel Update5Remedial Measures1. Options2. Solution6Further WorkGSA ModelHand Calculations7Decision1. DiscussionOriginal Design ProblemsGuidelines8MentionsTable 2: Probationary Chapter Headings2.

Preliminary Background ReviewThis background reappraisal gives a brief history of the quiver job in edifice floors and so focuses on research directed

towards leisure centre type floors and applicable burdens. There is a treatment of quiver acceptableness in this scenario and current methods of work outing possible quiver issues. At the terminal of this subdivision, a reappraisal of current design usher is given, as applicable to anyone in the UK look intoing a composite-sectioned floor, with worlds as the quiver ‘ receivers ‘ .

2. 1 Vibration of floorsVibration of floors has most probably been an issue since freestanding floors were foremost constructed centuries ago. Old references to floors are difficult to happen but the power of quiver jobs has been known for a long clip. In 1831, soldiers processing across Broughton Suspension Bridge in Manchester made it vibrate to the point of resonance and complete prostration.

Some marks are still around that used to teach soldiers to interrupt measure when traversing the span (Debney and Willford, 2009) . There have been some high profile instances even with modern span designs and the topic is decidedly still germinating (Pavic et al, 2002) . With respects to technology research, it was non until comparatively late that efforts have been made to truly understand the mechanics of the job. Previously, typical technology opinion of the Victorian epoch was employed, and solutions were found in over-engineering constructions so they could defy quiver. In the 1960 ‘ s research was started with basic theoretical accounts being developed giving applied scientists ‘ ushers to happen cardinal frequences of floors with manus computation such as the home base and shell theories presented by the celebrated S. Timoshenko. This initiated as at that clip other progresss in

structural technology meant igniter, more efficient constructions were being developed which were more susceptible to quiver. For structural floors, it was thought that if the natural frequence of the floor could be kept above the applied excitement frequence there would be no job.

However this turned out to be unacceptable. In peculiar in the last 20 old ages at that place has been a rush in research in response to new even more slender floors being constructed. Some such research (Pavic, 1998) was against new guidelines produced to get by with a new tendency towards greater crossing office floors (i. e.

fewer columns) with less damping (i. e. partitions/paper processing/storage systems etc) . The guidelines were deemed over-conservative or besides were used falsely and the furniture indoors would coggle somewhat. Over conservative guidelines are a job because, for illustration, increasing a slab ' s thickness by 50mm can add 10s of 1000s of lbs. Of class there is a tradeoff with acceptableness. Experiment has led to an betterment in the general overall theory and apprehension of the basicss of the job.

Floors can be excited into gesture by harmonics (multiples) of the cardinal frequence and modern floors with lower multitudes are really sensitive to this phenomenon. More elaborate analyses are now used were computing machine theoretical accounts are made and existent response to burden is calculated and compared to acceptance standards, described in more item in subdivision 2. 2. As seen with office floors, similar jobs started looking in shopping Centres, wellness nines and secondary schools (Mouring, 1996) .

A individual walking can do quiver which will rag users and so this is a serviceableness issue.

However quiver due to more intense ‘ crowd ‘ actions can do greater motions and so really can go a safety issue (Ji, 1994) . Correcting jobs after building is really expensive (Allen, 1990) . Secondarily every bit good as alterations in edifice architecture there was an addition in degree of activities such as aerobic exercises with newfound audience engagement, so coupled with the aforesaid lessening in edifice floors stiffness ‘ s and damping, jobs were discovered. Troubles of this nature were highlighted in a instance survey of the dynamic behavior of a secondary school floor (Rainer and Swallow, 1986) . The floor was designed to the so most advanced quiver usher from Canada ; CAN3-S16 Appendix G and passed standards for design (based on walking) . Nevertheless debatable quivers were detected in the survey when exercisings of other more rhythmic nature were carried out. In response Ji & A ; Ellis were prompted to co-author two documents in 1994, supplying the theory and a confirmation of the response computations for floors under dance and exercise-type burden still in usage today. Now it is understood that the cardinal manner of quiver can non be the lone cheque, but, as this undertaking should foreground there are still jobs in industry.

However it is expected that this is due to incompetence on the design squad ‘ s portion, as there are assorted guidelines that try to do applied scientists cognizant that floors can non be excited into resonance (i. e. big amplitude quivers) . In the Eurocodes (mandatory design ushers as of April 2010) the lone existent valuable mention to quiver is in the National Annex to BS EN

1991-1. 1 (Euro code 1) . It states that floors may be unaffected by resonance phenomena if its perpendicular cardinal frequence is above 8.

4Hz. This figure comes from consideration of the first three harmonics of the mean walk-to force (3 x 2. 8Hz = 8. 4Hz) . As mentioned earlier harmonics are of import as they can excite a floor into quiver.

Harmonizing to the national extension, if the cardinal frequence of a floor is below 8. 4 Hz so a dynamic analysis is required. For farther examination a figure of secondary ushers are available. The Steel Construction Institute ‘ s Guide P354 and the American Institute for Steel Construction ‘ s Design Guide 11 are two relevant illustrations. Further item covered in Section 2.

2 & A ; 2. 3. Pavic and Reynolds (2002) produced two big literature reappraisals which round together much of the separated research from the yesteryear into a individual papers. As they province, structural quiver is n’t solved by any one individual procedure, it is a mix and lucifer of different reappraisals and ushers, “ there is no whole-package solution ” .

2. 2 Modeling dynamic human burdenThe thought of doing a mathematical theoretical account of human motion is non new and research covers many subjects. In civil technology the motions of people and in peculiar groups of people are of overriding involvement as they can greatly magnify warps on overcrossings, bowl, stairwaies and floors. Two lading methods need to be looked at, one sing an single walking or jumping, and one sing a group of people dancing or exerting. The worst instance for the group scenario is leaping (Ellis, 1994) , as maximal force arises when burden is both

synchronized and periodic (Ellis, 2000) . ISO 10137 assumes the overall motion of a group of people does n’t alter and characterises the burden for different state of affairss values at 0. 25 persons/m2 for aerophilic and gymnasium activities and 2 persons/m2 for societal dance activity.

Besides it is assumed one individual ‘ s weight norms at 746N. (76kg x 9. 81ms-2 = 746N) . Loading on a floor is modelled by utilizing half sine pulsations, stand foring footfall contact and the point of zero foot/floor contact. For different activities this force will be transferred in different ways, and so each activity is therefore described by a different contact ratio I±c (which can be thought of a force multiplier) , doing the force more intense for a vigorous activity. The SCI method considers frequences in the scope of 1. 8 – 2. 2 Hz but there are other scopes available for illustration the method developed by Arup, where walking frequences considered are 1.

0 – 2. 8 Hz. The burden map is expressed as a Fourier series summing these contact points: whereQ = wieght of people per unit country (746N per person)I±h = dynamic burden factor (DLF – table 3)H = harmonic figurefp = frequence of the jumping burdenI¦h = stage slowdown (clip difference) for the activityCurrent SCI P354 recommends factors arising from Ji and Ellis 1994.

h= 1h= 2h= 3h= 4H = 5H = 6Low impact aerobic exercisesI±c= 2/3I±hI¦h9/7- Iˆ/69/55-5 Iˆ/62/15- Iˆ/29/247- Iˆ/69/391-5 Iˆ/62/36- Iˆ/2High impact aerobic exercisesI±c= 1/2I±hI¦hIˆ/202/3- Iˆ/2002/15- Iˆ/2002/35- Iˆ/2Normal jumpingI±c= 1/3I±hI¦h9/5Iˆ/69/7- Iˆ/62/3- Iˆ/29/55-5 Iˆ/69/91-

Iˆ/62/15- Iˆ/2Table 3: Phase slowdowns and DLFsFor ordinary walking besides tested by the VES, the burden map is assumed to be absolutely periodic ;(Eq 2)Using different DLF ‘ s calculated from table 4HarmonicHFrequency scope (Hz)hfpDLFI±hPhase slowdown (rad)I¦h11. 8 to 2. 20. 436 (hfp – 0.

95)023. 6 to 4. 40. 006 (hfp + 12. 3)-Iˆ/235. 4 to 6.

60. 007 (hfp + 5. 2)Iˆ47.

2 to 8. 80. 007 (hfp + 2. 0)Iˆ/2Table 4: Walk DLFsIt is interesting to observe there is ongoing research work to better the above traditional theoretical account (Racic, 2009.) Alternatively of utilizing the periodic half sine footfall Racic makes a new theoretical account closer to that of the close periodic world, by the amount of two Gaussian exponentials combined with the equations of round gesture to bring forth an unreal jumping force. This makes it more realistic than the traditional method, there is improved curve suiting around the measured jumping force signal, by holding two extremums alternatively of one.

The section for structural technology at Sheffield University is entering a database of assorted leaping parametric quantities composed by proving different persons at changing round frequences on metronome. The thought behind this is to develop probability-based stochastic theoretical accounts that can be used to account for the variableness of different individuals leaping within kineticss in civil technology. 2. 3 Analysis and Modelling of FloorsFor any floor of irregular form manus computations are non suited and so the lone manner frontward is to utilize a more advanced method. Some

package plans exist that work on geometric and material belongingss. Numerous editions exist, including those marketed with floor makers such as Westok. They are particularly limited and are truly merely utile as a usher at a peculiar set burden with and normally doing premises for a regular square shaped floor program. Finite Element (FE) modeling uses computing machine power to see many points in infinite and clip and develop big mass and stiffness matrices used to work out the standard quiver Eigen job, doing it possible to give many more consequences over iterative stairss.

A uninterrupted construction is broken into a finite figure of elements. Modes higher than the cardinal manner are calculated and complex time-varying burden maps and agreements on different countries of a floor can be used. This method has gained popularity in structural technology but evolved from mechanical and aeronautical subjects of technology (Reynolds, 2000) . There are several FE bundles available to the structural design applied scientist.

LUSAS, Nastran, SAP2000, ABAQUS etc. are capable of average analysis nevertheless for quiver analysis the plans lack general popularity so are n’t a major pick for this undertaking. As possibility of salvaging money was mentioned before, it should be noted that an FE analysis can easy use more than ten 1000 lbs. Oasys GSA is marketed as to the full comprehensive for quiver jobs, with walking, running, dancing burden capablenesss, besides leting any geometry to be specified. Different eigenvalue analyses can be performed (Modal/Ritz/Modal P-delta etc) . However its finite elements

capablenesss have merely been added comparatively late to the codification and its usage and options is limited.

The most advanced codification is ANSYS. Developed in 1970 in the US this plan has huge modeling capablenesss and is widely used even outside of structural technology. The usage of changing elements allows different features of solid stuffs to be modelled. Radio beams are easy created but for a concrete slab there are a figure of considerations. For quiver of a home base, a normally used component tyoe is ‘ SHELL63 ‘ (Pavic et al 2001) which represents an elastic shell with bending and membrane actions within orthotropic 6 DOF ‘ s. Pavic said traditionally there are jobs in taking element type but besides how to near the dynamic modulus of snap, Ec, dyn.

As, in kineticss generated emphasiss are much lower than that of a inactive analysis, and this should be carefully approached (Wyatt, 1989) . If required an ‘ extra ‘ stiffness can be smeared over the top of the shell elements. In a dynamic analysis the connexions of a theoretical account must besides be carefully considered, as pinned connexions may act in a fixed mode if frequences are high plenty. If one floor of a construction is of concern so the whole edifice is non required in the theoretical account (Middleton, 2008) . Besides in his literature reappraisal Middleton explains that the columns above and below the floor are of importance in the theoretical account, and the node denseness has an consequence on the frequence scope (El-Dardiry, 2006) . SCI P354 besides gives specific information on patterning floor decks with profiled steel sheeting. The wide attack will be either to take spectrum analysis of jumping/dancing frequences and utilize Fourier

constituents to see whether it interferes with the natural frequence of the floors (or its harmonics) or utilize average superposition in which the part from each manner is considered and summed to give entire burden.

For floors capable to rhythmic activity should be analysed for all manners up to the cut off frequence of 24Hz plus 2Hz so wholly modes up to 26 Hz should be considered harmonizing to P354. Modal superposition is anticipated for the undertaking. For the undertaking, cardinal points have been established so far, in line with SCI P354. ConsiderationNotesconnexionsinternal: theoretical account as to the full fixedfrontage: fixed but have rotational capacitycolumnsmethod 1: above and below to pinned connexions (full floor tallness)method 2: above and below to fixed point of inflexion (normally half storey tallness)masssef-weight + permanent loads + a proportion of imposed tonss as moderately can expected to be lastingno. of elements in meshsufficient in measure when measure can be doubled without significantly impacting consequencesEc, dyn38gpa for normal weight concrete22gpa for lightweight concreteresponse locationaccelerations calculated for locations that are occupied and connected to, but are non, the country of rhythmic activityTable 5: Proposed theoretical account featuresA point to note is besides that it is non necessary to utilize the package ‘ s in-built geometry editors, as it is possible to input geometry from CAD drawings into GSA and via convertor package into ANSYS.

However for the undertaking it is planned to utilize bids entered into an ASCII file loaded into ANSYS to salvage cumbrous attempt and let uninterrupted

alteration. If required and if possible, formalizing FE theoretical accounts is done with average testing, which provides ‘ real universe ‘ consequences of a construction. The trial piece (construction) is aroused and its quiver manner belongingss recorded (natural frequences, manner forms and muffling ratios) . This engineering requires sensitive mensurating techniques as civil technology constructions ‘ quiver response is really little and competes with a big degree on environmental noise (Pavic, 1999) and was non available pre mid 1990 ‘ s as transducers were non sensitive plenty. When by experimentation proving floors with average analysis there are two methods available (Rainer and Swallow, 1986) nevertheless merely one will be mentioned here as is relevant to the undertaking.

Shaker proving involves puting a reciprocating ‘ shaking ‘ weight, driven by a known signal. Accelerometers record the motion of the floor and, when these two pieces of equipment are methodically placed at different grid locations on a floor it is possible to enter manner forms and phase slowdown of the response, i. e. the clip difference between the coercing action on the floor and its associated response. After entering manner shapes the excitement can be stopped suddenly and the quiver decay of the floor measured for computation of the muffling ratio (Rainer & A ; Swallow, 1986) .

2. 4 Acceptability of quiversThe susceptibleness of worlds to quiver of floors is a comparatively new research field, and although this has been intense most of it is directed to quiver effects from a one individual scenario. BS6472 and ISO 10137 describe assorted methods to which dynamic responses can be evaluated for office floors and floors keeping sensitive equipment

nevertheless there is no by and large accepted standard for constructions keeping a crowd (SCI P354, 2007) . The problem is the trouble is quantifying quivers as perceptible or upseting for worlds varies greatly from individual to individual. The AISC recommend for a floor topic to rhythmic lading 4 to 7 % gravitation is a peak acceleration bound (AISC Design Guide 11, 1997) , this is tantamount to a response factor of 120 (SCI P354, 2009) . However these ushers emphasise the deficiency of certainty on these values. Another method of quantifying tolerance is the quiver dosage value (VDV) as described in BS6472 and SCI P354. Mathematically the technique is to take the root-mean-quad of the clip incorporate acceleration signal (depicting every bit much of the quiver as possible) after it has been weighted against a standard graphical curve.

This procedure can depict quivers in footings of acceleration, exposure clip and frequence of exposure. The ushers describe values applicable to people in grandstands that would be upseting, unacceptable or likely to do terror. It is false people in these constructions are in a similar place to those in gyms/dancehalls where jumping as a crowd is the worst instance scenario. In gyms and dance floors people are by and large traveling and will hold a higher degree of quiver tolerance.

However countries of concern are likely to be those where residents may non be taking portion in the dynamic burden, i. e. there is the possibility with edifices designs that another country of the floor may go aroused. For illustration a map room for nuptialss could hold people sitting and dancing within the same topographic point. This scenario would necessitate careful

checking. All counsel must be reviewed all careful picks made on how to judge the quiver bounds. 2.

5 Extenuation of quiversStructures should be designed to suit for dynamic tonss induced within their life-time but of class, erroneously, this does non ever go on. The demand for retro-fitting of constructions with a method of muffling quivers has had some high profile instances. It is dearly-won for the clients and sometimes rather hard to accomplish. There are assorted methods applicable in different state of affairss, but in general modal mass (i. e. part to quiver) must be decreased or muffling ratio increased. ISO 10137 recommends: a) displacement resonance frequence of the transmission construction or the receiving system (change mass or stiffness) ; B) add muffling to cut down response at resonances (frictional or hydraulic dampers, tuned mass dampers) ; degree Celsiuss) control the dynamic belongingss of the beginning (shift rotational frequence of operation, balance revolving machinery, control traffic velocity or path of vehicles, better surface or subsurface belongingss of roadway or railroad, etc.) ; vitamin D) isolate the quiver beginning, such as debut of barriers to vibration transmittal (trenches or hemorrhoids for ground-transmitted quivers, proper techniques and air blast control for blaring in the land) ; vitamin E) isolate construction by active or inactive quiver isolation (servo-controlled mass or reactions, seismal or pneumatic isolation of instruments, jumping isolation of edifice constituents or of the full construction) .

Care needs to be exercised so that the alterations made do non accidentally deteriorate the quiver degrees due to elaborations of hitherto hibernating

manners of quiver. In general, it is preferred to use quiver extenuation in the design stages, instead than as a remedial step after the edifice is completed and occupied. One of the simplest but frequently most impractical methods of adding stiffness to a lively construction is by adding columns supports or poising to it. This can non ever be accommodated for, particularly after building, without damaging the intent of the construction. There it necessary to see some other options but limit these to quiver serviceableness jobs due to human burden and non seismal lading from temblors. Tuned mass dampers (TMD) map by absorbing the energy of motions through viscousness or stiffness of some fluid or stuff. In this manner muffling is increased.

An advanced engineering in this field is Magneto-Rheological TMDs. They work by adding micro magnetic atoms to the oil in a TMD and so puting this fluid under a magnetic field, which, when required can aline the atoms in the most compressive way and bring forth more stiffness. These elements are designed or ‘ tuned ‘ to work with a construction ‘ s natural quiver frequences. 4.

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