
Lee Xue Jing, freelance dancer / dance instructor
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Kinematics of jumps and its correlation with dance floor and shoes

Farah Fadzali, November 2020

Dance training is characterised by a systematic progression of repeated motions while biomechanics observe forces acting on the body, which contribute to an understanding of the technical demands and the artistry of dance. This article will explore the kinematics (study of motion) of jumps and its correlation with dance floor and shoes.

Understanding jump: Forces acting on the lower body and potential contribution from the upper body

Dancers move through space vertically and horizontally, jumping both for height and to travel through space. When jumping straight up and down (e.g. sauté in first position), dancers are incurring a force that is anywhere from three to five times their body weight[24]. Jumps, such as grand jeté which travels through space, also incur a horizontal force upon landing. The

"breaking" action in the anterior thigh muscles (quadriceps group) creates a shearing force at both the ankle and knee[3]. This force occurs between the upper and lower leg, with the greatest force seen at the muscles and soft-tissue of the knee[20].

Beyond the issue of strength and muscle recruitment of the leg muscles, additional focus on the action of the whole body is an important consideration in jumping. Dancers need to control movement of the upper body (i.e. head, shoulders, hips) in both take-off and landing, keeping the body from bending forward or arching back.

Flooring

The floor surface on which dancers perform has been suggested to be vital in providing shock absorption for dancers' landing a jump to reduce stress on the body. Dance floor has been attributed as a factor of dance safety. Hard and non-resilient flooring have been suggested to contribute to overuse syndromes, stress fractures, and acute ankle sprains[15,16,18,23]. It was reported that 23.4% of student dancers believed that dance floor was one of the causative factors for injuries[22] whilst 12.7% of all accidents reported in professionals and student dancers were due to a fault with flooring[22]. The most common complaint was slippery floor and too much friction between the foot/shoe and the floor[17,22].

Lee Xue Jing, freelance dancer / dance instructor
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Types of Dance Floor

Floors developed for general industrial, commercial or sports applications do not offer the benefits that dancers appreciate when they talk about the 'feel' of the floor. An ideal dance surface is one that offers the right degree of 'traction' or 'grip' that guards against the risk of slipping or falling and the sufficient amount of spring provided by the sprung sub-floor beneath the dance surface.

A sprung floor is a floor that provides some degree of bounce and flexes under impact giving a softer feel (not as bouncy as a trampoline). Performers need a floor to absorb the shock of repeated impact to their joints and reduce injury from falls. Modern sprung floors are supported by foam backing or rubber pads while traditional floors provide their spring

through bending woven wooden battens[5]. Semi-sprung floors are designed to dampen bounce[5]. Very thick vinyl flooring is often referred to as semi-sprung[5].

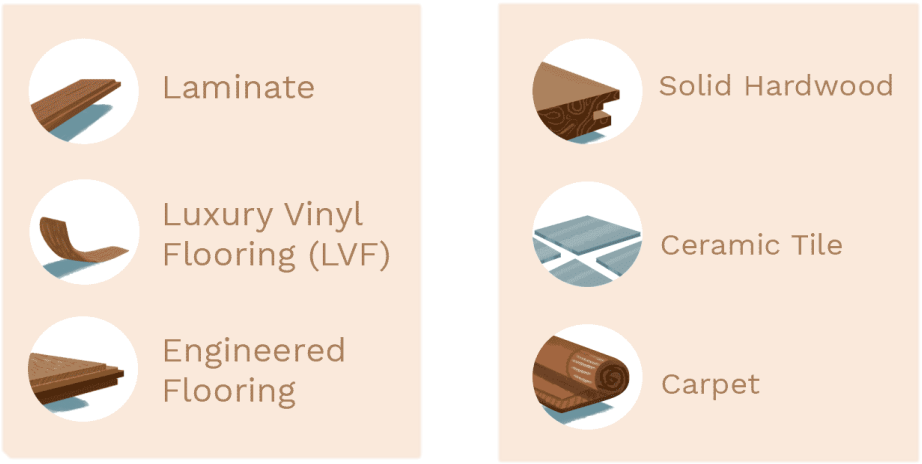

Fig. 1, Different types of dance flooring

A hard, stiff and unsprung floor may present an injury risk to dancers. When a floor surface is too "firm/hard" (e.g. concrete/ hardwood/ marble/ brick flooring), it will require the lower limbs to absorb a lot of energy during landings (from a jump) and this may present as an injury risk, particularly when considering the repetitive nature of dance.

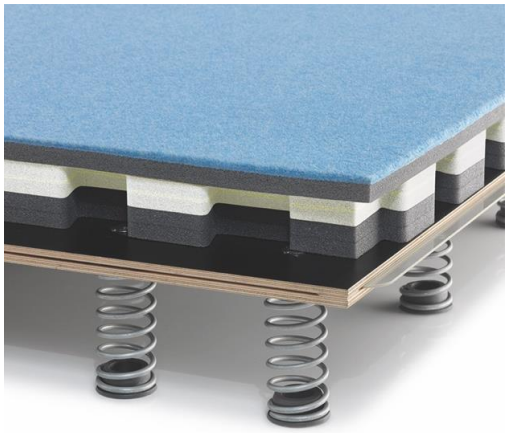

Fig. 2, SPIETH Gymnastics Flooring

Conversely, if the floor surface is able to absorb too much energy, early onset fatigue may occur in dancers, which may also have associated injury risks. It is a common assumption that a well-designed sports floor will suit the needs of dancers, but there are two major differences in the flooring here which are the construction of the sprung sub-floor and the performance surface[5]. The misconception here is dancers having the same requirements as athletes when it comes to floor criteria. Sprung floors for sports are tested for adequate ball bounce and athletes require a high degree of energy return. Evidently, dancers are less interested in a ball bounce and are focused on a combination of shock absorption and energy return[5]. Understanding the appropriate floor surfaces for dancers is crucial especially for touring companies. It is possible that some theatre venues may not be equipped with floor surfaces that is suitable for dancers as they are constructed to house theatrical performances and may not fulfil the athletic requirements of dancers. If dancers are trained on a floor that is too soft (Fig. 2), chances are their bones

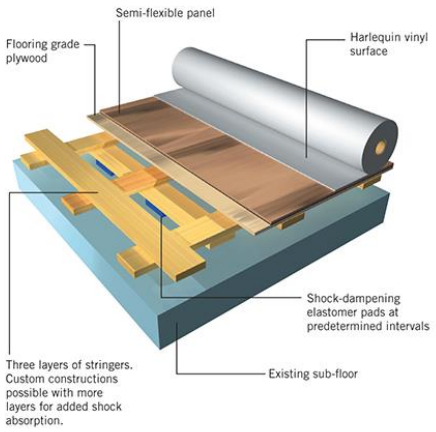

Fig. 3, Harlequin Sprung Floor System

may not be able to adapt to the harder floor surfaces that they are required to perform on. For example, jumping on a super soft/ fully sprung flooring (like a trampoline) and afterwards having to perform the same jump on a concrete floor, dancers will feel a surprise effect and over time, training under such flooring may then lead to fatigue mechanisms[5,6]. It was suggested that an ideal dance floor is one with shock absorbing properties – able to absorb energy without deforming the floor permanently (Fig. 3)[4,5,8,19].

"*a dance floor should be neither too supple nor too soft. A hard floor has the effect of causing serious return shock waves and can bring about injuries or premature wear in the cartilage whereas a floor that is too soft can be dangerous for dancers because of the effect of surprise*"[5] - Dr. Boni Rietveld, MD, BA (Mus.), orthopaedic surgeon of the Medical Center for Dancers and Musicians in The Hague

Footwear

Lee Xue Jing, freelance dancer / dance instructor
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Dancers use footwear during dance activities that provide little impact attenuation when performing in a well-rehearsed and controlled environment[8]. Most genres such as ballet and jazz employ specific types of shoes. These dance shoes are minimally force dispersive by nature of their construction – having a layer or two of leather/microfiber material. However, footwear like pointe shoes, have been associated with foot pain and injuries as it usually compromises the midfoot ligaments[2,7,8,12]. Overuse of the tap shoes too may lead to common injuries such as tendonitis (inflammation of a tendon) as well as ankle and toe fractures. This are mainly due to the construct of tap shoes that do not absorb the shock of pounding movements[9]. Others like the flamenco high heels are suggested to be the cause of both feet and lower limb injuries[12]. Similarly, unshod dancers from genres like modern/contemporary/ethnic dancers too are at risk of common lower limbs injuries[8,16].

Common problems

Fig. 4, Parquet Flooring

The most common problem seen when prioritising dancer's health and safety is when both dance organisations and dance schools are on a tight financial budget. Oftentimes, principals or dance teachers in these areas are not well equipped on the health and safety practises required by the dancers.

As such, students spent most of their time training on either concrete/parquet flooring (i.e. community centres). It is utmost important to recognised between a normal parquet flooring and a sprung flooring (which is ideal for shock absorbency and longevity of dancer's career).

Fig. 5, Harlequin Floors – **Harlequin Activity**® multipurpose sprung floor system

Besides understanding the requirements of suitable flooring and footwear for the safety of every dancers, dance teachers/schools may adopt the use of technology to augment the trained eye through biomechanical analysis. This is relevant to teaching, as it not only validates but clarifies what is practiced in the dance studio for the betterment of the training of dancers and the future of performance[4,16].

Other considerations should the cost of proper dance flooring be too extensive:

1. Proper foot wear

2. When doing jumps during a practice session, one may consider placing a portable non-slip mat for example yoga mat in order to absorb more force

3. When training for a long term in a particular venue, dance instructors should consider their long-term lesson plans in order to reduce any negative impacts on the joints. Dance instructors should also look into space alternatives such as playground, field, or sports field.

End

An MSc in Dance Science graduate from Trinity Laban Conservatoire of Music and Dance, Farah has multiple experience in teaching movement therapy in various organisations in Singapore.

Farah is now a dance science researcher studying injury prevention and performer's health and safety practices. Together with her achievements and qualifications, Farah hopes to work towards the development of dance science research in Singapore.

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