

UNIT III - ENGINEERING ETHICS LEARNING FROM DISASTERS

1) Write a short note on the crew of Space Shuttle Challenger?

A) The crew of Space Shuttle Challenger consisted of seven astronauts:

(1) Francis R.Scobee-Mission Commander (2) Michael J.Smith-Pilot (3) Gregory B.Jarvis—Payload Specialist 1 (4) Christa McAuliffe-Payload Specialist 2 (5) Judith A.Resnik-Mission Specialist 1 (6) Ellison S.Onizuka-Mission Specialist 2 (7) Ronald E.McNair-Mission Specialist 3.

This mission was highly publicized because it was the first time a school teacher, ChristaMcAuliffe from New Hampshire was allowed to travel in space.

2) When was Challenger launched?

A) Space Shuttle Challenger was launched from Cape Canaveral; Pad 39 B at Kennedy Space Center in Florida at 11:38 am EST on January 28, 1986.The Space Shuttle Challenger Mission (Flight STS-51L) was the 25th Space Shuttle mission and the 10th launch of the Space Shuttle Challenger. The Challenger Cargo included two satellites – (1) Tracking Data Relay Satellite -2(TDRS-2): Communications satellite (2) Spartan satellite for the observation of Halley’s Comet.

3) The date for the launch of Space Shuttle Challenger was changed several times. What were the reasons for this?

A) *Challenger* was originally set to launch on July, 1985, launch was rescheduled to late November 1985 due to changes in payloads. It was again rescheduled for January 22. Delays in the previous mission, STS-61-C, caused the launch date to be moved to January 23 and then to January 24. The launch was then rescheduled to January 25 due to bad weather at the Transoceanic Abort Landing (TAL) site in Dakar, Senegal. NASA decided to use Casablanca as the TAL site, but because it was not equipped for night landings, the launch had to be moved to the morning (Florida time). Predictions of unacceptable weather at KSC on January 26, caused the launch to be rescheduled for 09:37 EST on January 27.The launch was delayed the next day, due to problems with the exterior access hatch. First, one of the micro-switch indicators, used to verify that the hatch was safely locked, malfunctioned.Then, and a stripped bolt prevented the closeout crew from removing a closing fixture from the orbiter's hatch. By the time repair personnel had sawed the fixture off; crosswinds at the Shuttle Landing Facility exceeded the limits for a Return to Launch Site (RTLS) abort. While the crew waited for winds to die down, the launch window expired; forcing yet another scrub.The launch on January 28 was delayed two hours when a hardware interface module in the launch processing system, which monitors the fire detection system, failed during liquid hydrogen tanking procedures.

4) What was the main cause of the disaster?

A) The **Space Shuttle Challenger disaster** occurred on January 28, 1986, when the NASA Space Shuttle orbiter *Challenger* (OV-099) (mission STS-51-L) broke apart 73 seconds into its flight, leading to the deaths of its seven crew members. The spacecraft disintegrated over the Atlantic Ocean, off the coast of Cape Canaveral, Florida, at 11:39 EST (16:39 UTC). Disintegration of the vehicle began after an O-ring seal in its right solid rocket booster (SRB).These rubber rings sealed the joint between the two lower segments of the booster. Design flaws in the joint and unusually cold weather during the launch caused the O rings to allow hot gases to leak out of the booster through the joint. Flames from within the booster streamed past the failed seal and quickly expanded the small hole. The flaming gases then burned a hole in the shuttle’s external fuel tank. The flames also cut away one of the supporting beams that held the booster tore loose and ruptured the tank. The propellants from the tank formed a giant fireball as structural failures tore the vehicle apart.

5) “There should be perfect coordination between the officials and the engineers to avoid accidents like space shuttle challenger disaster. “Do you agree with this view? Justify your views.

A) Yes, I agree with this. The space shuttle challenger disaster occurred due to improper coordination between the officials and the engineers. Top level decision makers had not been informed of problems with the joints and O rings .If the officials listened to engineers, this would not happened.

6) “Public money is unscrupulously wasted in the name of space research”.Express your opinions regarding this statement.

Yes because

Currently, one of the major concerns of the world is wasting of money. Space exploration is an activity which needs huge reserves. Some individuals think that money should be spent on other programs which enhances people basic needs and living standard. To my mind, I completely agree with this notion.

To begin with, space exploration helps us to find new lands, new sources of energy and potential threats to the globe. The advances in these areas are very essential for future needs. For instance, it is a known fact that we are running out of petroleum or nuclear products. The scientists should come with new alternatives of energy for our survival. Moreover, astronauts should warn us before some danger happens to our earth. To achieve all these, nations should fund in exploration.

However, dwellers in the world are facing significant number of issues. Firstly, many country people are suffering to get food, clean water and, shelter and also have no clothes to cover their body. Secondly, many children in developing countries who live in country side are not having access to education system due to lack of facilities. Moreover, every day, new form of virus or diseases are affecting people’s health. Government should spend to find cures for these harmful bacteria. For example, researchers are not able to find medicines for lung cancer, HIV, and AIDS from a long time.

To sum up, nations should think about investing in space research only when human basic needs are satisfied. Countries which have contributed to space tour should spend money on developing poor countries.

No because

If we have to use the money for something I would strongly approve that we use it for space exploration. Let’s say the world is on its edge and we have to get off of the earth then we could take rocket ships and we could live on the moon. If we continue space exploration we could probably find a planet that has water or oxygen. Space exploration is all about moving to new, uncharted territory and learning more about the final frontier. On a more prosaic note, it has a great value for the future of mankind. The mark of human civilization is its ability to explore space and learn more about its surroundings. If we lose our scientific curiosity, it will strike a big blow to the very foundation of human existence. The mark of space exploration is to increase the technological sophistication of our civilization. Without exploration of space, we would not have learnt about solar flares or meteors. It is critical for us to think about the importance of the world as it stands in relation to outer space if we ever want to solve the mystery of human existence. The mark of any civilization, whether ancient or modern is its knowledge about space and outer space. Space exploration is not a waste of money.

Biotechnology: Ethical Questions

1) What is the difference between ‘biology’ and ‘biotechnology’?

A) The fundamental difference between biology and biotechnology is that biology is a **science**, whereas biotechnology is an **industry**. Specifically, biology is the branch of science concerned with living things whereas biotechnology is an industry which applies biology to the solution of real world problems.

2) What is one of the major roles of biotechnology?

A) **Biotechnology** is the use of living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use". Depending on the tools and applications, it often overlaps with the (related) fields of bioengineering, biomedical engineering, biomanufacturing, etc.

For thousands of years, humankind has used biotechnology in agriculture, food production, and medicine. The term is largely believed to have been coined in 1919 by Hungarian engineer Károly Ereky. In the late 20th and early 21st century, biotechnology has expanded to include new and diverse sciences such as genomics, recombinant gene techniques, applied immunology, and development of pharmaceutical therapies and diagnostic tests.

Medicine: In medicine, modern biotechnology finds applications in areas such as pharmaceutical drug discovery and production, pharmacogenomics, and genetic testing (or genetic screening).

Agriculture: Genetically modified crops ("GM crops", or "biotech crops") are plants used in agriculture, the DNA of which has been modified with genetic engineering techniques. In most cases the aim is to introduce a new trait to the plant which does not occur naturally in the species.

Industrial biotechnology: Industrial biotechnology (known mainly in Europe as white biotechnology) is the application of biotechnology for industrial purposes, including industrial fermentation.

Animals (Selective breeding): Biotechnology has achieved some dramatic advances in recent years in both crop and livestock production. These include transferring a specific gene from one species to another to create a transgenic organism; the production of genetically uniform plants and animals (clones); and the fusing of different types of cells to produce beneficial medical products such as monoclonal antibodies. Today, biotechnology has a number of applications in livestock production. It is being used to hasten animal growth, enhance reproductive capacity, improve animal health and develop new animal products.

3) Are you in favour of genetic engineering and selective breeding? Why?

A) **Genetic engineering**, also called **genetic modification**, is the direct **manipulation** of an organism's genome using biotechnology. It is a set of technologies used to change the **genetic** makeup of cells, including the transfer of **genes** within and across species boundaries to produce improved or novel organisms.

If Yes: 1. With genetic engineering, most of the diseases and illnesses can easily be prevented through isolating the exact gene that causes them.

2. There are also infectious diseases that can be treated with the use of genetic engineering. This is done by implanting the genes that are associated with antigen and antiviral proteins.

3. The most desirable traits of certain organisms can be pin pointed and integrated into other organism's DNA.

4. Genetic engineering has the ability to increase the genetic diversity as well as produce variant alleles that can be implanted to other species. It is also possible to change the heredity of the wheat plants and grow insulin.

If No : 1. There are scientists who believe that the existence of hereditarily modified genes can have an irreversible effects and associated consequences.

2. Genetic engineering can hinder the moral issues particularly in religion. They also wonder if man has the ability and right to influence the course and law of nature.

3. There are also professional scientists who manipulated the so called genetic sequence to obtain the main purpose of human reproduction organs that are intended for health purposes.

4. The process of genetic engineering is quite tricky and risky process and you need to gather a wide variety of information before attempting to engage in the process of genetic engineering

Selective breeding (also called artificial selection) is the process by which humans use animal **breeding** and plant **breeding** to **selectively** develop particular phenotypic traits (characteristics) by choosing which typically animal or plant males and females will sexually reproduce and have offspring together.

If Yes :

- 1. Higher Yield of Goods:** The main reason for selective breeding in the first place is to increase the amount of milk, meat, eggs, or fruits that are produced by the animal or plant. This has been successfully done many times and continues to be done today.

- 2. Healthier Animals:** With selective breeding, certain diseases and illnesses that would normally take the lives of many animals can be eradicated. This results in longer living animals.

- 3. Unsuitable Conditions:** When it comes to plants that are bred with selective breeding, there are many different benefits. One of them is that they can be tailored to grow on land or soil that they would normally not be able to. This opens up the possibilities for cultivation.

- 4. Most Nutrition Provided:** Plants and animals can be bred to have more nutritional value. This is a great benefit because that nutrition is passed on to the consumers.

- 5. Breeds out Harmful Traits:** Any traits that are harmful to the species as a whole, or are unnecessary obstacles in the harvesting process can be successfully bred out of the animals.

- 6. Variations of Species:** New breeds of species can be developed using selective breeding. This is beneficial to the people as well as the animals that are in the wild.

If No :

- 1. Inhibits Evolution:** The frequency that certain alleles are introduced into a species is drastically cut down with selective breeding. This could cause a severe lack of evolution in species where it would naturally occur.

- 2. Harmful Pathogens:** While certain pathogens that cause disease and illness may be eradicated, it could provide ideal situation for new and more harmful ones to develop. These new pathogens would then continue to be passed down during the breeding process.

- 3. In Breeding Risks:** One great example of inbreeding that has resulted in devastating effects is the white tiger. They have been in bred so long, in order to obtain the striking white color that severe mutations have begun to occur. These same risks apply to any livestock or plants that are being in bred in order to achieve supreme traits.

- 4. Other Animals Unable to Feed:** Animals that rely on certain nutrients and traits of plants may no longer be able to feed off of ones that have been selectively bred. This is because these traits can be flushed out of them completely.

- 5. Very Time Consuming:** Since it takes time to know if a trait has been passed down, selective breeding takes a lot of it. Especially in the case that the trait was not passed down or eliminated. The process must start over again.

4) 'Animals rights are as important as human rights '.Express your views regarding this statement.

A) A growing number of people feel that animals should not be exploited by people and that they should have the same rights as humans, while others argue that humans must employ animals to satisfy their various needs, including uses for food and medical research. Animal rights are benefits people give to animals. Benefits include the right of protection from human use and abuse and rights can take moral, legal and practical forms. People who support animal rights believe that animals are not ours to use as we wish, for whatever purpose, be it for food, clothing, experimentation or entertainment. Animal rights supporters also believe that we should consider the best interests of animals regardless of whatever value the animals may have for us.

With regard to the exploitation of animals, people believe it is acceptable for several reasons. Firstly, they think that humans are the most important beings on the planet, and everything must be done to ensure human survival. If this means experimenting on animals so that we can fight and find cures for diseases, then this takes priority over animal suffering. Furthermore, it is believed by some that animals do not feel pain or loss as humans do, so if we have to kill animals for food or other uses, then this is morally acceptable.

However, I do not believe these arguments stand up to scrutiny. To begin, it has been shown on numerous occasions by secret filming in laboratories via animal rights groups that animals feel as much pain as humans do, and they suffer when they are kept in cages for long periods. In addition, a substantial amount of animal research is done for cosmetics, not to find cures for diseases, so this is unnecessary. Finally, it has also been proven that humans can get all the nutrients and vitamins that they need from green vegetables and fruit. Therefore, again, having to kill animals for food is not an adequate argument.

To sum up, although some people argue killing animals for research and food is ethical, I would argue there is sufficient evidence to demonstrate that this is not the case, and, therefore, steps must be taken to improve the rights of animals.

5) List the health problems caused in human beings because of the consumption of broiler chicken.

A) The major health problems caused in human beings because of the consumption of broiler chicken are Bird Flu, The intestinal bacterium *Enterococcus faecalis* can transmit from chickens to humans, causing urinary tract infections. Generally, people get sickened by these three bacterial pathogens Salmonella spp., Campylobacter spp., and E. coli after eating improperly cooked and handled meat and eggs that have been contaminated with the germs, not by handling live and healthy chickens.

"If antibiotic resistance develops in animals, it can be transmitted to humans and cause serious treatment problems. Potent antibiotics that are currently reserved for humans should not be used on animals. The bacteria could become resistant to antibiotics that would otherwise be used as a last resort for humans."

6) Express your views about the practice of using animals for experiments.

Nowadays animal experiments are widely used to develop new medicines and to test the safety of other products. Some people argue that these experiments should be banned because it is morally wrong to cause animals to suffer, while others are in favour of them because of their benefits to humanity. It is true that medicines and other products are routinely tested on animals before they are cleared for human use. While I tend towards the viewpoint that animal testing is morally wrong, I would have to support a limited amount of animal experimentation for the development of medicines.

On the one hand, there are clear ethical arguments against animal experimentation. To use a common example of this practice, laboratory mice may be given an illness so that the effectiveness of a new drug can be measured. Opponents of such research argue that humans have no right to subject animals to this kind of trauma, and that the lives of all creatures should be respected. They believe that the benefits to humans do not justify the suffering caused, and that scientists should use alternative methods of research.

On the other hand, reliable alternatives to animal experimentation may not always be available. Supporters of the use of animals in medical research believe that a certain amount of suffering on the part of mice or rats can be justified if human lives are saved. They argue that opponents of such research might feel differently if a member of their own families needed a medical treatment that had been developed through the use of animal experimentation. Personally, I agree with the banning of animal testing for non-medical products, but I feel that it may be a necessary evil where new drugs and medical procedures are concerned.

In conclusion, it seems to me that it would be wrong to ban testing on animals for vital medical research until equally effective alternatives have been developed.

7) What is meant by 'Sentience'?

A) **Sentience** is the capacity to feel, perceive, or experience subjectively. Eighteenth-century philosophers used the concept to distinguish the ability to think (*reason*) from the ability to feel (*sentience*). In modern Western philosophy, sentience is the ability to experience sensations (known in philosophy of mind as "qualia"). In Eastern philosophy, sentience is a metaphysical quality of all things that requires respect and care. The concept is central to the philosophy of animal rights, because sentience is necessary for the ability to suffer, and thus is held to confer certain rights.

Transgenic animals

1) What does the term 'transgenic animals' mean?

A) A transgenic animal is one that carries a foreign gene that has been deliberately inserted into its genome. The foreign gene is constructed using recombinant DNA methodology. These are the animals that have been deliberately bred for research and that contain elements of two different species.

- Transgenic sheep and goats have been produced that express foreign proteins in their milk.
- Transgenic chickens are now able to synthesize human proteins in the "white" of their eggs.

In July 2000, researchers from the team that produced Dolly reported success in producing transgenic lambs in which the transgene had been inserted at a specific site in the genome and functioned well.

Transgenic **mice** have provided the tools for exploring many biological questions.

An example:

1) Normal mice cannot be infected with polio virus. They lack the cell-surface molecule that, in humans, serves as the receptor for the virus. So normal mice cannot serve as an inexpensive, easily-manipulated model for studying the disease. However, transgenic mice expressing the human gene for the polio virus receptor

- can be infected by polio virus and even
- develop paralysis and other pathological changes characteristic of the disease in humans.

2) Transgenic animals, i.e., engineered to carry genes from other species, have the potential to improve human welfare in:

- agriculture, such as larger sheep that grow more wool
- medicine, such as cows that produce insulin in their milk
- industry, such as goats that produce spider silk for materials production

2) Why do scientists show interest in developing transgenic animals?

A) Scientists show interest in developing transgenic animals as they are benefits such as

1. They are used in clinical trial research.

One of the benefits of transgenic animals, according to proponents, is in pharmaceuticals. In order to create new medicines for different diseases, scientists need models for diseases. These animals are used in laboratories for clinical trial research. With their help, pharmaceuticals are able to come up with the cure for certain diseases.

2. They can be organ donors in the future.

Advocates for animal transgenesis claim that significance of transgenic animals in xenotransplantation, a process of transplanting a cell or tissue from another species for medical purposes. The pigs have organs similar to humans in size and are readily available but their tissues age much faster. Proponents say that there will be a time animal organs can be used on people waiting for donors.

3. They can be used by diabetes patients who need insulin as well as patients with several diseases like sickle-cell anemia.

Supporters of the use of transgenic animals point out their importance for people who need insulin treatment and those who are undergoing treatment with the use of gene therapy. By genetically modifying DNA, these animals can produce human drugs like insulin, vaccines and blood clotting factors VIII and IX, among others.

4. They can be used to keep infants healthy.

Through the process of transgenesis, modifying the genes of a parent animal can produce offsprings with qualities human beings can make use of. According to proponents, scientists were able to modify a cow and the result is an offspring that can produce milk with casein, a kind of protein used for cheese manufacturing. These cows can now also produce lactoferrin which can be found in the immune system. This can be used as an additive to infant formula.

5. They can be used in agriculture and livestock.

People in favor of the production of transgenic animals maintain that farmers and consumers can enjoy the benefits from raising these animals. With the use of this biotechnology, cattle and sheep can already be used in transgenesis. With this, farmers can have healthier animals and in the long run, this type of meat will be allowed to be used for human consumption

3) Do you agree with the ethical issues raised in the passage? Can you counter some of the arguments offered?

A) Yes, I agree with the ethical issues raised in the passage.

Ethical, moral and religious concerns

Altering the genetic material of animals raises a whole host of ethical, moral and religious questions.

1) Changing the genetic make-up of animals compromises their essential nature and fails to respect their unique identity. Inserting the gene of one organism into another can give that organism a competitive advantage that it would not naturally have. If the transgenic organism were to escape confinement, it might outcompete others, leading to endangerment or extinction of a species.

2) Inserting human genes into non-human organisms and vice versa blurs the line between human and non-human. Since many ethical systems make distinctions between human and non-human, this can cause an ethical dilemma. For example, many people believe its okay to kill an animal, but not a human. Then, is it okay to destroy bacteria that have been genetically engineered to produce a human hormone for medical purposes? Is it okay to kill a mouse that has been genetically engineered to produce human skin for skin grafts? How many human genes does an organism have to have before it becomes human?

3) Manipulating the genome of any organism causes some people to think that scientists are "playing God". Some people believe that the natural order of life should not be changed. This view can be overly simplistic, since people manipulate nature all the time, but there is the matter of the degree or amount of manipulation that is happening in use of transgenes that raises ethical questions.

4) Deliberately designing animals to suffer, as disease models inevitably do, is morally repugnant.

5) GM animals are more than likely to suffer in unexpected ways as well as in the ways intended by their manipulators. Altering animals' genes without knowing the consequent harm they will suffer raises fresh ethical problems.

4) What are the religious issues regarding the creation of transgenic animals?

Religion plays a crucial part in the way some people view animal biotechnology. For some people, these technologies are considered blasphemous. In effect, God has created a perfect, natural order, they say, and it is sinful to try to improve that order by manipulating the basic ingredient of all life, DNA. Some religions place great importance on the "integrity" of species, and as a result, those religion's followers strongly oppose any effort to change animals through genetic modification.

Not all religious believers make these assertions, however, and different believers of the same religion might hold differing views on the subject. For example, Christians do not oppose animal biotechnology unanimously. In fact, some Christians support animal biotechnology, saying the Bible teaches humanity's dominion over nature. Some modern theologians even see biotechnology as a challenging, positive opportunity for us to work with God as "co-creators."

Transgenic animals can pose problems for some religious groups. For example, Muslims, Sikhs and Hindus are forbidden to eat certain foods. Such religious requirements raise basic questions about the identity of animals and their genetic makeup. If, for example, a small amount of genetic material from a fish is introduced into a melon (in order to allow it grow to in lower temperatures), does that melon become "fishy" in any meaningful sense? Some would argue all organisms share common genetic material, so the melon would not contain any of the fish's identity. Others, however, believe the transferred genes are exactly what make the animal distinctive; therefore the melon would be forbidden to be eaten as well.

5) 'DNA manipulation is an inhuman attempt to cause chaos to the world'. Do you agree with this?

A) Yes I agree with this. DNA Manipulation is an attempt to cause chaos to the world as

- God laid down the structure of creation and any tampering with it is sinful.
- Manipulating DNA is manipulating 'life itself' - and this is tampering with something that God did not intend humanity to meddle with.

6) Imagine the sufferings of the transgenic animals in laboratories and describe their painful experiences.

A) We must fight against the spirit of unconscious cruelty with which we treat the animals. Animals suffer as much as we do. True humanity does not allow us to impose such sufferings on them. It is our duty to make the whole world recognize it. Until we extend our circle of compassion to all living things, humanity will not find peace. ~Albert Schweitzer, *The Philosophy of Civilization* .

Transgenic animal research involves many species: mice, rats, hamsters, guinea pigs, fish, chickens, rabbits, pigs, sheep, cows, goats, horses and primates. They are infected with dozens of diseases and toxins, in dozens of different ways. They are given genes to express or suppress specific proteins, enzymes, or allergens to develop resistance to drought, pollens, toxins, with endless experiments on their immune systems. Many species of animals are used in this research. But mice are the favourite (at present) and their use is rocketing - up by 960% over the past 10 years, with this rate of increase predicted to continue for the foreseeable future. In order to create a new strain of transgenic mice, young females are injected with powerful hormones to make them super ovulate. After mating, they are killed to extract the embryos, which are microinjected with the foreign DNA. These altered embryos are then surgically implanted into many surrogate mothers, who have also been hormone-injected to assist implantation and who will later be killed before or after giving birth. Many of the resulting baby mice are malformed and die before or shortly after birth. The surviving babies have to be tested to see if they have the new gene: this can be done by saliva or faecal sampling but is more often conducted by cutting off the tips of their tails or a notch from their ears. Only 1-10% of the baby mice will have successfully incorporated the new gene. The other 90-99% will be destroyed as 'failures'. This translates into so much killing that many of the animal technicians responsible for killing all the 'waste' animals find it traumatic and are left feeling 'physically and emotionally exhausted'. Apart from death, there are the issues of harm, pain and suffering. The impact on the animals varies depending on the procedures, as some transgenic techniques are more harmful or painful than others.

7) 'Scientists are unsympathetic people as far as transgenic animals are concerned.' What is your reaction to this statement?

A) Yes, Scientists are unsympathetic people as far as transgenic animals are concerned. As in Q6. (Suffering of animals)

8) Do you expect the government to ban the research involving transgenic animals?

A) No, I don't want the government to ban the research involving transgenic animals. As in Q2. (benefits of transgenic animals)

Natural Disaster-Earthquake

1) What is a natural disaster? Give examples.

A) A natural disaster is a major adverse event resulting from natural processes of the Earth; examples include floods, volcanic eruptions, earthquakes, tsunamis, and other geologic processes. A natural disaster can cause loss of life or property damage, and typically leaves some economic damage.

2) Why do earthquake occur?

A) An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. At the Earth's surface, earthquakes manifest themselves by vibration, shaking and sometimes displacement of the ground. Earthquakes are caused mostly by slippage within geological faults, but also by other events such as volcanic activity, landslides, mine blasts, and nuclear tests. The underground point of origin of the earthquake is called the *focus*. The point directly above the focus on the surface is called the *epicenter*. Earthquakes by themselves rarely kill people or wildlife. It is usually the secondary events that they trigger, such as building collapse, fires, tsunamis (seismic sea waves) and volcanoes, which are actually the human disaster. Many of these could possibly be avoided by better construction, safety systems, early warning and planning.

3) List the types of damage caused by earthquakes.

A) The ground shaking may also cause landslides, mudslides, and avalanches on steeper hills or mountains, all of which can damage buildings and hurt people. The second main earthquake hazard is ground displacement (ground movement) along a fault.

4) 'Earthquake serves as a wake-up call'. What does this sentence mean?

A) Wake-up call is an event that warns someone that they need to deal with an urgent or dangerous problem. Similarly Earthquake is also an event which warns someone to deal with the dangerous problem.

Ex: The 1971 earthquake was a wake-up call to strengthen the city's bridges.

5) What happened as a result of the earthquake near the Sikkim-Nepal border?

A) 66 people have been killed and many more injured in India as well as in neighbouring Nepal and Tibet,China. Buildings and roads in Sikkim have been badly damaged.

6) Why should we give importance to quake-resistant construction?

A) Earthquakes constitute one of the greatest hazards of life and property on the earth. The earthquake resistant construction is considered to be very important to mitigate their effects. Earthquake-resistant structures are structures designed to withstand earthquakes. While no structure can be entirely immune to damage from earthquakes, the goal of earthquake-resistant construction is to erect structures that fare better during seismic activity than their conventional counterparts.

According to building codes, earthquake-resistant structures are intended to withstand the largest earthquake of a certain probability that is likely to occur at their location. This means the loss of life should be minimized by preventing collapse of the buildings for rare earthquakes while the loss of functionality should be limited for more frequent ones.

7) Write a short note on the earthquake in the Caribbean island of Haiti.

A)Haiti earthquake of 2010, large-scale earthquake that occurred January 12, 2010, on the West Indian island of Hispaniola, comprising the countries of Haiti of Caribbean island and the Dominican Republic. Most severely affected was Haiti, occupying the western third of the island. An exact death toll proved elusive in the ensuing chaos. The official Haitian government count was more than 300,000, but other estimates were considerably smaller. Hundreds of thousands of survivors were displaced.

The earthquake hit at 4:53 pm some 15 miles (25 km) southwest of the Haitian capital of Port-au-Prince. The initial shock registered a magnitude of 7.0 and was soon followed by two aftershocks of magnitudes 5.9 and 5.5. More aftershocks occurred in the following days, including another one of magnitude 5.9 that struck on January 20 at Petit Goâve, a town some 35 miles (55 km) west of Port-au-Prince. Haiti had not been hit by an earthquake of such enormity since the 18th century, the closest in force being a 1984 shock of magnitude 6.9. A magnitude-8.0 earthquake had struck the Dominican Republic in 1946.

8) Multi-storey buildings and apartment buildings have become common in towns and cities. What are your suggestions to builders in view of the damages earthquakes could cause?

A) Most houses of up to four storeys in India are built of burnt clay brick masonry with reinforced concrete slabs. Depending on the building and the seismic zone of its location, certain earthquake resistant features are required in such buildings as per the Indian codes, e.g., the lintel band, corner reinforcement, etc. However, such a seismic features are often not provided in the buildings due to a variety of reasons. On the other hand, a number of such buildings in the urban areas now tend to include a number of small reinforced concrete columns. One could combine these building elements into a rational structural system of "confined masonry" which will have far better earthquake performance. Similarly, many new four or five storey "reinforced concrete frame" buildings being constructed in small and large towns lack a proper frame system, and either do not undergo formal structural engineering or undergo inappropriate structural engineering. Most of the 130 multi-storey apartment buildings that collapsed in Ahmedabad in the 2001 earthquake fall in this category. Again, it should be possible to construct such apartment buildings in confined masonry without incurring additional costs and without having to go for newer building materials.

Says Anita Puri, Assistant Chief Architect, Ansal Buildwell Ltd., "The Bureau of Indian Standards (BIS) lays down different criteria for different earthquake prone zones in the country. Registered structural engineers give projects a 'structure certificate', copies of which we give to the buyers as well at the time of booking. In fact, the structural engineers oversee the construction of the projects from time to time to ensure that the laid-down standards are adhered to."

Buyers must ensure that the builder gives them the 'structure certificate' and can, if they want, check if earthquake resistant elements (in the foundation, depth of the project, reinforcement of walls, plinth beams etc.) have been incorporated. For a clearer understanding, some of the less known facts about earthquake protection of buildings are: There is no such term as "earthquake proof" as no building can be entirely safe from earthquakes. The actual term to be used is "earthquake resistant", which means that minimum damage to life and property is caused following an earthquake. Earthquake resistant design as per the Indian Seismic Code is the minimum permissible earthquake protection to be followed in the country. The Indian code gives freedom to users to design for higher levels of protection.