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Treatment of Dairy Wastewater Aided with Simultaneous Electricity Generation Using Dual Chambered Microbial Fuel Cell

SANJAY S
Alva's Institute of Engineering & Technology, Moodbidri, Karnataka, INDIA
Email: *sanjay.sjce@gmail.com*

Abstract: *Exploiting wastewater as substrate to harness electricity is considered as sustainable approach for reducing the impacts of load and volume in effluent treatment at a dairy industry. Microbial fuel cell is a device that converts organic matter present in wastewater into electricity using micro-organisms as biocatalysts. MFCs are considered to be very popular and promising bio-electrochemical power source for directly recovering electrical energy from organics present in wastewater. This paper mainly focuses on generation of power from dairy wastewaters and also simultaneous removal of organics employing a Dual chambered microbial fuel cell (DC-MFC) with graphite electrodes. Maximum COD removal efficiency of 82.4% and Maximum BOD removal efficiency of 86.46% was achieved. Also a maximum of 232 mv of power was generated. Thus making this reactor a very efficient in treating dairy wastewater and simultaneous power generation.*

Keywords: *Dairy wastewater, DC-MFC.*

1. Introduction

Among all the industries, the food sector consumes large quantity of water and in turn produces large quantity of effluents per unit produce. The dairy industry is an example of this sector, in which the cleaning silos, tanks, heat exchangers, homogenizers, pipes and other equipment, give rise to a large amount of effluents with a high organic load. This organic load is basically constituted by milk (raw material and dairy products), flooding the effluent with high levels of chemical oxygen demand (COD), biochemical oxygen demand (BOD), oils and grease, nitrogen and phosphorus. Treatment of dairy effluents therefore remains one of the challenges present days. Application of Dingle chambered microbial fuel cells (DC-MFC) represents a new approach to wastewater treatment with simultaneous generation of sustainable clean energy. This paper mainly focuses on generation of power from dairy wastewaters as also simultaneous removal of organics employing a Dual chambered microbial fuel cell (DC-MFC) with graphite electrodes.

2. Materials and Methodology

The dairy wastewater was retrieved from the raw effluent tank from Mysore Milk Dairy (MYMUL) to fuel the DC-MFC cell. Cow dung (maintained at anaerobic condition) was used as inoculum. Cow dung being inexpensive, provides a diverse microbial population more resilient to changes in wastewater than as seen in pure bacterial cultures.

The rectangular type DC-MFC fabricated in the present experimental set up was constructed of 6mm Perspex glass. A barrier/separation wall (3cm) was composed of glass wool and glass bead sandwiched between thin Perspex permeable walls was constructed. Thus the DC-MFC cell was divided into cathode and anode compartments. The cathode and anode compartments were consisted of graphite electrodes, each positioned in cathode and anode electrodes. The rectangular graphite electrodes used in the present experimental cell was (1.5cm thick). The influent fuel was introduced to the DC-MFC cell by means of an inlet facility which had a tap facility. The outlet the DC-MFC cell consisted of an opening (20mm diameter) through which the effluent passed out of the DC-MFC cell. A copper wire used to connect the graphite electrodes to the external circuit across a load or external resistance. Inside the DC-MFC cell the naked copper wire was held in contact with the electrodes, whereas the copper wire extended outer to the DC-MFC cell connecting the electrodes to the external circuit had insulation.

Seismic Assessment of Multistory Symmetric and Asymmetric Buildings Using Equivalent Static and Response Spectrum Analysis

Madhukaran[1], Dr. H. Eramma[2], Sandeepkumar.D.S[3], Raghavendra.M.R[4]
Dept of Civil engineering
UBDTCE, Davanagere.

Abstract- *In the current study we have modeled symmetric and asymmetric buildings such as H-shape, L-shape, Long slender shape, Rectangular shape and T-shape buildings for G+5, G+10 and G+15 stories using ETABS 9.7 non-linear version software. We have compared base shear, lateral displacement and story drift values for Equivalent static and Response spectrum analysis. And we have observed that symmetric buildings are comparatively more suitable to take earthquake load compared to asymmetric buildings*

Keywords**-** About Equivalent Static,Response Spectrum, base shear, story drift and lateral displacement.

I. INTRODUCTION

Static linear analysis defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. In this method, mass of the structure multiplied by design seismic coefficient, acts statically in a horizontal direction. It is also assumed here that the magnitude of the coefficient is uniform for the entire members of the structure. Design shears at different levels in a building shall be computed from the assumption of linear distribution horizontal accelerations, varying from zero at the base of the structure to a maximum at the top. For important and complicated structures this method is not adequate.

The total design lateral force or design base shear along any principal direction is given in terms of design horizontal Seismic coefficient and seismic weight of the structure. Design horizontal seismic coefficient depends on the zone factor of the site, importance of the structure, response reduction factor of the lateral load resisting elements and the fundamental period of the structure.

Following procedure is generally used for the equivalent static analysisaccording to IS 1893 – 2002.

i) Calculation of lumped weight.
ii) Calculation of fundamental natural period.

The fundamental natural period of vibration (Ta) in seconds of a moment resisting frame building,

$Ta = 0.075\ h^{0.75}$ (without brick infill panels)
$Ta = 0.09\ h/\sqrt{d}$(with brick infill panels)

Where

h = Height of the building
d = Base dimension of the building at the plinth level in m, along the considered direction of the lateral force.

iii) Determination of base shear (VB) of the building.

VB = Ah x W

$$A_h = \frac{Z}{2}\frac{I}{R}\frac{S_a}{g}$$

Where,

A_h is the design horizontal seismic coefficient, which depends on the seismic zone factor (Z), importance factor (I), response reduction factor (R) and the average response acceleration coefficient (Sa/g). Sa/g in turn depends on the nature of foundation soil (rock, medium or soft soil sites), natural period and the damping of the structure.

iv) Lateral distribution of design base shear;

The design base shear VB thus obtained is then distributed along the height of the building using a parabolic distribution expression:

$$Q = V_B \frac{W_i h_i}{\sum_{j=1}^{n} W_j h_k^{\ 2}}$$

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Performance evaluation of G+5, G+10 and G+15 story symmetric and asymmetric buildings using Pushover analysis.

Madhukaran[1], Dr.H.Eramma[2], Sandeepkumar.D.S[3], Raghavendra.M.R[4]

[1,2] Faculty Civil Engineering Department, UBDTCE, Davanagere
[3,4] Students UBDTCE, Davanagere

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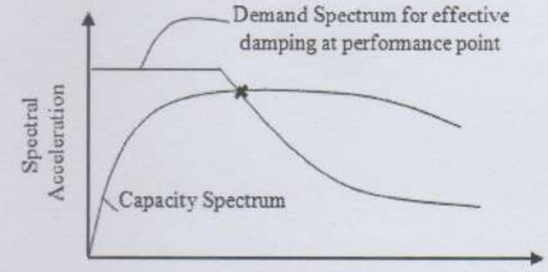
Abstract - *In the current study we have modeled symmetric and asymmetric buildings such as H-shape, L-shape, Long slender shape, Rectangular shape and T-shape buildings for G+5, G+10 and G+15 stories using ETABS 9.7 non-linear version software. We have plotted Pushover graphs compared earthquake demand V/S capacity of the building using non-linear static Pushover analysis. We have observed that capacity of the symmetric buildings is much higher than asymmetric buildings.*

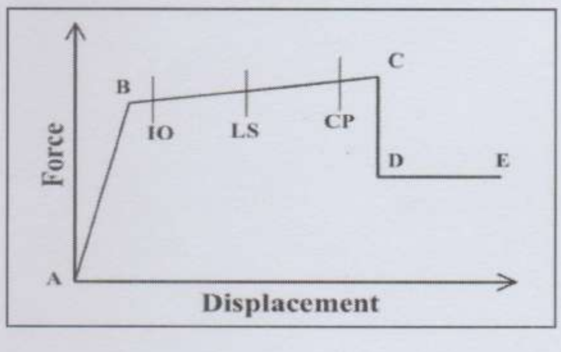
Key Words: Pushover, Capacity spectrum, hinges and performance.

I. INTRODUCTION

The Pushover Analysis or Non–Linear Static analysis Procedure is defined in the Federal Emergency Management Agency document 356 (FEMA 356) as a non–linear static approximation of the response a structure will undergo when subjected to dynamic earthquake loading. The static approximation consists of applying a vertical distribution of lateral loads to a model which captures the material non–linearity of an existing or previously designed structure, and monotonically increasing those loads until the peak response of the structure is obtained on a base shear vs. roof displacement plot. At the University of Ljubljana this method for simplified push-over analysis has been developed, which is intended to achieve a satisfactory balance between required reliability and applicability for everyday design use, and which might contribute to the practical implementation of new trends in seismic design (Kilar, 1995). It is based on an extension of the pseudo three-dimensional mathematical model of a building structure into the inelastic range. The method was implemented into a prototype of the interactive and user friendly computer program NEAVEK. In the paper the method is briefly described and applied. The graphical presentation makes possible a visual evaluation of how the structure will perform when subjected to earthquake ground motion (Freeman, 1998). The capacity of the structure represented by a force displacement curve is obtained by non-linear static pushover analysis. The base shear forces and roof displacements are converted to the spectral accelerations and spectral displacements of an equivalent Single-Degree-Of-Freedom (SDOF) system, respectively. These spectral values define the capacity spectrum. The demands of the earthquake ground motion are defined by highly damped elastic spectra. The Acceleration Displacement Response Spectrum (ADRS) format is used, in which spectral accelerations are plotted against spectral displacements, with the periods represented by radial lines (Fajfar, 1999). The intersection of the capacity spectrum and the demand curve provides an estimate of the inelastic acceleration and displacement demand. In this paper, the result of the pushover analysis was compared with the existing BNBC 1993 response spectrum.



Plastic Hinge:



Plastic hinges are defined at the end of the Beam and Column element as per FEMA 356 standard. The nonlinear load deformation relationship is shown in the Figure 4 where generalized force versus deformation curves used to specify component modelling and acceptance criteria for deformation-controlled actions (FEMA 356, 2000). The unloaded condition is expressed as point A whereas B corresponds to effective yield point. The slope of BC is generally taken from 0 to 10 percentage of the initial slope. This line BC represents strain hardening

Seismic assessment of multistory symmetric and asymmetric buildings with and without friction dampers

Madhukaran, Dr.H.Eramma* Sandeepkumar.D.S**, Raghavendra.M.R***

Civil engineering department, UBDTCE, davanagere.

***ABSTRACT-** In the current study we have modeled symmetric and asymmetric buildings such as H-shape, L-shape, Long slender shape, Rectangular shape and T-shape buildings for G+5, G+10 and G+15 stories with and without friction dampers using ETABS 9.7 non-linear version software. Friction dampers act like fuses in the building. Just like fuses protect electrical circuit Friction dampers protect building by reducing the earthquake load on the buildings. In the current study we have observed that time period, lateral displacement and story drift get reduced but the story shear get increased by the use of friction dampers in the building.*

Index Terms- Symmetric, asymmetric, Friction Dampers and base shear.

I. INTRODUCTION

Structural vibration control, as an advanced technology in engineering, is to implement energy dissipation devices or control systems into structures to reduce excessive structural vibration, enhance human comfort and prevent catastrophic structural failure due to strong winds and earthquakes. Structural control technology can also be used for retrofitting of historical structures especially against earthquakes. The common sense approach to vibration control of structures is with vibration damping that is added to a structure either passively or actively. The damping dissipates some of the vibration energy of a structure by either transforming it to heat or transferring it directly to a connected structure.

The friction dampers have advantages such as simple mechanism, low cost, less maintenance and powerful energy dissipation capability as compared to other passive dampers. They were found to be very effective for the seismic design of structures as well as the rehabilitation and strengthening of existing structures.

They provide a practical, economical and effective approach for the design of structures to resist excessive vibrations. However, modelling of frictional force in the damper is quite a cumbersome process, as the number of equations of motion varies depending upon the non-slip and slip modes of vibration.

A damper is a mechanical element that eliminates or progressively diminishes oscillations. It dissipates energy in the form of heat instead of storing it. The application of direct damping through friction systems permits plastic behavior by providing non-linearity while allowing the structure itself to remain elastic. The systems, carefully controlled by a sliding surface, feature a very large initial stiffness and the possibility of nearly perfect rectangular hysteretic behavior There are two main types of friction dampers in use in steel-framed buildings. Rigid frame friction dampers, providing real plastic hinges which may be replaced easily following an earthquake, and Braced frame friction dampers, which utilize diagonal bracing which slips at a predetermined stress.

Friction dampers: It has been a common practice among mechanical engineers to apply friction-based brakes to absorb kinetic energy in machines and devices. This has encouraged the development of Pall friction based damper (Chandra [6]). Pall friction dampers have successfully gone through sophisticated experimental studies on shake tables in Canada (Filiatrault [3]) and the United States (Aiken [7]). Pall friction dampers have been very attractive due to their simplicity and low cost of construction. High seismic performance of Pall's damper has been a great motivation to extend its application out of its origin to other countries, especially to United states. General structure of Pall type dampers is made up of some steel plates layed on each other with high strength bolts pressing them together, generating friction between them. Contrary to Viscoelastic systems, Pall system is not sensitive to environmental temperature and state of loading. Pall system's hysteretic behaviours are almost rectangular and completely similar to ideal elasto plastic behaviour. Due to high dissipation energy capacity and stability of hysteresis loops, Pall system seems to show higher seismic performance, than other damping systems.

Design of Pavement Surface for Sustainable Development Using Micro Silica and Copper Slag

[1]Shravana, [2]Nicole Pinto, [3]Sachin H Dias, [4]Praveen, [5]Anusha B Rao

[1,2,3,4]UG Student, [5]Assistant Professor
Department of Civil Engineering
SMVITM, Bantakal, Udupi

Abstract—— **Cement concrete has established its own position among the modern construction materials. Concrete is a basic material used in almost every type of construction, consisting of aggregates that are bond by cement and water. At present, carbon emission and sand mining are major concern due to its hazardous effect to environment and making serious imbalance to the ecosystem. In the construction industry, cement is the main material for the concrete production. The production of cement involves the emission of carbon dioxide during its production. Various studies have been conducted in this regard to reduce severe effect on environment, using industrial by-products like micro silica as partial replacement for cement and copper slag as partial replacement of fine aggregate. The main focus of this experimental program is to investigate the effects of using micro silica partially replacing cement by 0%(control mix), 3%, 6%, 9%, 12% and copper slag partially replacing fine aggregate by 0% (control mix), 20%, 40%, 60% for M50 grade of concrete to know its strength properties without any mineral or chemical admixtures.**

Index Terms— **concrete, micro silica, copper slag, cement, fine aggregate, strength.**

I. INTRODUCTION

It was observed and noted that since decade of years that the cost of building materials is currently so high that only corporate organization, individual, and government can afford to do meaningful construction. Waste can be used as filler material in concrete admixtures in cement and raw material in cement clinker, or as aggregates in concrete. Concrete is a blend of cement, sand, coarse aggregate and water. Cement concrete most widely used construction material all over the world. It is a material, which is used more than any other man made material on the earth for construction works. In concrete, cement chemically reacts with water and produces binding gel that binds other component together and creates stone type of material. The reaction process is called 'hydration' in which water is absorbed by the cement. In this process apart from the binding gel, some amount of lime [$Ca(OH)_2$] is also liberated. The coarse and fine aggregates act as filler in the mass.

In the present scenario, environmental pollution is the biggest menace to the human race on this planet causing ecological imbalance. There are many reasons which cause pollution. In the construction industry, cement is the main ingredient for the concrete production. The production of cement involves the emission of carbon dioxide during its production. There are two different sources of carbon dioxide emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcimining limestone to lime in the cement kiln also produces carbon dioxide. In India about 2,069,738 thousands of metric tons of carbon dioxide was emitted in the year of 2015. The cement industry contributes about 5% of total global carbon dioxide emissions. The cement is manufactured by using the raw materials such as limestone, clay and other minerals by procuring them by quarrying process which also causes environmental degradation. To produce 1 ton of cement, about 1.6 tons of raw materials are required and the time taken to form the lime stone is much longer than the rate at which humans use it.

Aggregate is the main constituent of concrete, occupying more than 70% of the concrete matrix. River Sand or natural sand is most common form of fine aggregate used in the manufacturing of concrete. In many countries, there is a scarcity of natural aggregate that is suitable for construction due to increased cost and large scale depletion of sources, whereas in other countries the consumption of aggregate has increased in recent years, due to increases in the construction industry. In order to reduce depletion of natural aggregates due to construction, artificially manufactured aggregate and some industrial waste materials can be used as alternatives. Many alternative materials with similar physical & chemical properties of sand are found and studies have been carried out to check the suitability of its use as partial replacement of sand.

On one side there is pollution caused due to cement production and there is depletion in the amount of sand and on the other side, the demand of concrete is increasing day by day for its ease of preparing and fabricating in all sorts of convenient shapes. So to overcome this problem, the concrete to be used should be environmental friendly. To produce environmental friendly concrete, it is necessary to replace the cement and fine aggregates with the industrial products such as Micro Silica (MS) and Copper Slag (CS) respectively.

Due to increase in industries, generation of industrial by-products was also increased. Micro Silica and Copper Slag are such by-products. Micro Silica is an ultrafine powder, and is light to dark grey in color. It is a co-product from the silicon or ferrosilicon industry and rich in silicon dioxide (SiO_2). When added to concrete improves the characteristics of concrete in two ways. Firstly due to its pozzolanic nature, chemically reacts with the calcium hydroxide leached out during the cement hydration leading to the increase in the amount of calcium silicate hydrate gel, thus improving the strength of the concrete. Secondly being an ultra-fine material physically fills the voids between cement particles making the concrete dense thus imparting water tightness